Employee health and firm performance*

Daniel A. Rettl
University of Georgia

Alexander Schandlbauer
University of Southern Denmark

Mircea Trandafir
Rockwool Foundation Research Unit and IZA

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Abstract

Using administrative data on the universe of private firms in Denmark, we find that even temporary and small health shocks to employee health like seasonal influenza can significantly reduce firm profitability. The effects are driven by labor-intensive firms and decrease in firm size and financial flexibility, suggesting that firms that are better able to shift resources can insulate themselves better. Our results indicate that employees are shielded from these negative effects, while owners (especially of small firms) see reduced dividends. Back-of-the-envelope calculations propose that all but the largest firms may benefit from subsidizing vaccination programs for their employees.

Keywords: firm performance, health shock, employee health, seasonal influenza
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*Rettl: Department of Finance, University of Georgia (email: daniel.rettl@uga.edu); Schandlbauer: Department of Business and Management, University of Southern Denmark (email: alsc@sam.sdu.dk); Trandafir: Rockwool Foundation Research Unit and IZA Institute of Labor Economics (email: mt@rff.dk). Schandlbauer is a research fellow of the Danish Finance Institute (DFI) and support from DFI is gratefully acknowledged. We thank Morten Bennedsen, Sonia Bhalotra, Thuy Duong Dang (discussant), András Danis, Sara Holland, Yi-Hsin Lo (discussant), Hannes Schwandt, and seminar participants at the 2023 FMA European Conference, 2022 NFA Workshop on Working Environment Economics, 2022 Annual Conference of the German Finance Association (DGF), 2021 Annual Conference of the European Association of Labour Economists, Vienna University of Business and Economics, Goethe University Frankfurt, Humboldt University Berlin, Rockwool Foundation, and the University of Georgia for helpful comments.

1 Introduction

Surveys of managers consistently indicate that firms incur substantial costs when workers are absent from work due to ill health. For instance, average absence rates across Europe are 3%–6% of working time, with an estimated aggregate cost of 2.5% of GDP (Edwards and Greasley, 2010). The total cost to employers is likely to be even higher because of presenteeism, i.e., productivity losses due to sick workers on the job (Grossman, 1972). Firms seem to increasingly consider employee health in the cost-benefit tradeoffs of their business decisions, as evidenced by the rise in corporate well-being programs during the last two decades. Still, a large number of firms (particularly small) do not enact policies to help prevent short-term employee health shocks (e.g., Buck Consultants, 2018), suggesting that either they do not internalize this risk or they evaluate the cost of prevention programs to be higher than the potential benefit. Yet the vast majority of research on the consequences of worker health focuses on the outcomes of the workers themselves (such as their labor force participation and employment, income, and long-term health), leaving the effects on their employers largely unexplored. In this paper, we aim to fill this gap by examining how employee bad health affects firm performance using a detailed register-based panel data set from Denmark over the period 1999–2016.

Denmark represents an ideal setting for our study. First, the richness of the administrative data allows us to link employee health to the performance of their employers, an exercise that is typically impossible with publicly available data. Second, the Danish labor market is characterized by "flexicurity," a system in which employers have the flexibility to hire and fire workers who are in turn protected by a generous safety net that provides income security (Humlum and Munch, 2023; Kreiner and Svarer, 2022). Finally, all Danish residents are covered by a comprehensive public health insurance plan. These features of the Danish labor and healthcare markets ensure that firm decisions and employment relations are not tainted by other considerations, such as firing costs or the need for employer-provided health insurance.

Simple correlations between firm performance and employee health are likely misleading. For example, in a labor market with compensating differentials, employees select employers with policies or work environments suited to their health status and accept wages that reflect the cost of these amenities to their employers. At the same time, when selecting different health-promoting policies or work environments, firms are likely to see distinct consequences for their performance. The choices made by employees and by firms can lead to a spurious correlation between worker health and firm performance. To uncover the causal effect of employee health on their employers, we rely on a change in employee health due to an event that is plausibly independent of firm policies: seasonal influenza, commonly known as the flu.

The seasonal influenza is an excellent candidate for a health shock in our framework. First, it affects a reasonably large share of the population, estimated at around 9% among working-age adults (Tokars et al., 2018). Second, influenza outbreaks generally occur during the winter months and, except for rare cases (usually among the very young or the very old), the flu typically has symptoms and complications that amount to a transitory health shock (Eccles, 2005). As a result, the workforce composition of firms should not be permanently affected by a flu outbreak. Finally, although influenza vaccines exist, there is no widespread resistance to the disease because the virus mutates from one year to the next and health organizations are not always able to predict the virus strain that will be prevalent every year. More importantly for our study, even if the virus strain could be predicted with high accuracy, vaccination rates vary widely and vaccination programs are generally not mandatory (nor free) in most countries. In Denmark, vaccination rates have traditionally been relatively low, reaching only 5%–10% of the working-age population.

To measure the change in the health of each firm's employees, we use detailed data on general practitioner (GP) visits. In particular, we take advantage of the fact that a specific type of blood test, the C-reactive protein (CRP) test, is commonly used in the Nordic countries to determine the appropriate course of treatment in patients with (severe) respiratory tract infections (e.g., Lykkegaard et al., 2021). This allows us to construct a proxy for the severity of the flu season at the firm-year level: the average number of CRP tests administered during the typical flu season. We find that firms whose employees are more affected by the flu experience a reduction in their performance in that specific year: a one standard deviation increase in the average number of CRP tests lowers the average operating return on assets and net income by approximately 0.15 percentage points.[1] This translates into a reduction of 68,835 DKK (USD 10,949) in operating profits and of 65,731 DKK (USD 10,456) in net income for the average firm in our sample. These findings are confirmed when we conduct our analysis within firms at the establishment level, an approach that allows us to eliminate time-varying unobserved firm characteristics that may be correlated with both firm-level profitability and local influenza outbreaks.

We can gauge the magnitude of these effects by comparing them to previous studies on the impact of various events and policies on firm performance. A severe flu season is equivalent to an approximately two- to three-day increase in the average number of days of absence among all employees (Bennedsen et al., 2019), a three-day hospital stay of the CEO (Bennedsen et al., 2020), approximately one tenth of the effect of adding one more board member to the firm (Jenter et al., 2023), or about one tenth of the effect of replacing a CEO of median talent with the most talented CEO (Falato et al., 2015). These magnitudes suggest that the average firm in our sample is affected by a severe flu season in a non-trivial way.

Our main conjecture is that employee health affects firm performance through changes in productivity or work absences. We provide suggestive evidence that our measure of flu severity is indeed related to absences from work and, to a lesser extent, worker productivity. If these are the only channels through which the intensity of the flu season affects firm performance, then we should observe two patterns in the cross-sectional relationship between the flu season and firm financial performance. First, all else equal, an influenza outbreak should have a stronger impact on firms in which human contact is more common, such as more labor-intensive firms. Second, firms that can shift resources to cover for sick employees should be more insulated from the effects of employee ill health. We confirm both of these patterns, as we find that our results are entirely driven by labor-intensive firms and that there is a monotonic relationship between the impact of the flu on firm profitability and the degree of financial flexibility or the number of employees in the firm. We also provide evidence that firms more likely to produce durable goods, in the manufacturing and construction industry, are much more affected by an influenza outbreak, suggesting

[1]For ease of exposition, in the rest of the paper we will refer to a one standard deviation increase in the number of CRP tests as a "severe flu season" or a "flu outbreak."

that our estimated effects are not due to changes in local demand.

Given our finding that influenza outbreaks negatively affect firm profitability, particularly among smaller firms, a natural question is how this shock is transmitted to two of the firms' most important stakeholders: employees and shareholders. We estimate economically insignificant reductions in wages and employment in small firms, suggesting that even they can shield their workforce from much of the temporary shock they experience during a severe influenza season. On the other hand, we find that these firms increase their cash holdings, are more inclined to hire temporary workers, and reduce their dividend payments. Hence, our results suggest that firms pass through some of the negative consequences of seasonal influenza to shareholders, but not to employees.

Our paper contributes to several strands of literature. Prior research shows that seasonal influenza has a significant cost burden on the macroeconomy (e.g., Peasah et al., 2013). Most studies quantify the cost by combining direct medical costs and indirect costs, which typically include lost earnings due to illness (reduction of individual worker productivity) and loss of life caused by influenza (e.g. Putri et al., 2018).[2] Our analysis quantifies the effect of seasonal influenza outbreaks on firm profitability, an important component of annual indirect costs.

We also add to the large literature on the consequences of worker health for the individuals themselves. These papers focus almost exclusively on outcomes such as labor force participation, employment, welfare dependence, and income (e.g., García-Gómez et al., 2013; Bradley et al., 2005; Smith, 1999). They typically rely on variation in worker health due to "extreme events" such as the onset of disability or cancer diagnosis (e.g., Kostøl et al., 2019; Autor et al., 2016; Bradley et al., 2002).[3] In contrast, we document how a common and transitory health condition, seasonal influenza, affects average worker wages and employment through its effect on firm profitability.

In addition, our paper is related to the growing literature on employee absen-

[2]Note that these estimates are obtained in the context of the US, where vaccination efforts resulted in higher vaccination rates than in many other developed countries, including Denmark.

[3]One other related paper documents the negative consequences of indirect exposure to the flu. Schwandt (2019) shows that maternal influenza infections during pregnancy are associated with worse health at birth and with long-term consequences such as lower earnings, decreased labor market participation, and higher rates of welfare dependence.

teeism. Recent papers study the determinants of absenteeism (Bennedsen et al., 2019) and its effects on productivity (Grinza and Rycx, 2020). Given that severe flu seasons lead to more absenteeism (Keech and Beardsworth, 2008; Akazawa et al., 2003), for which we also find suggestive evidence, our findings provide (indirect) evidence of a relationship between higher absenteeism rates and firm profitability.[4]

Another line of research we contribute to studies corporate risk management. Firms usually have an incentive to hedge against a variety of risks as they could otherwise face additional costs, constraints, or even bankruptcy (Stulz, 1996). Previous literature finds that firms hedge against e.g., exchange rate fluctuations (Allayannis et al., 2001), weather conditions (Pérez-González and Yun, 2013), CO_2 permit prices (Schopp and Neuhoff, 2013), input prices (Almeida et al., 2017), or supply chain disruptions (Kulchania and Thomas, 2017). Firms are also increasingly aware of the need to hedge against employee bad health, which they usually do through investments in employee health. However, these investments are typically made only by large firms and take the form of workplace wellness programs, which are programs designed to improve the health and general well-being of employees with a particular focus on reducing the chances of an "extreme health shock" like the ones described above (see the review in Baicker et al., 2010).[5] Our results suggest that smaller firms also have incentives to hedge against shocks to employee health, even if small and transitory.

The two closest studies to our paper estimate the effect of seasonal influenza on firm-level outcomes. Morris and Hoitash (2021) examine influenza infections in the context of firm-level accounting audits in the US. Exploiting time-series and cross-sectional variation in a measure that captures both the average spread and the severity of the flu at the state level, they find that audit quality suffers because the flu season overlaps with the busy audit season. Dorner and Haller (2020) analyze how local influenza intensity affects total factor productivity. They document that the length of the influenza season in German municipalities has negatively affected firm pro-

[4]Recent research emphasizes the importance of CEO health and absenteeism for firm performance (Bennedsen et al., 2020). Our results point to the fact that the health and absenteeism of rank-and-flie employees is also important for firm profitability.

[5]Much of the literature documents that these programs improve workers' health, increase their productivity, and reduce costs from absenteeism. Yet, recent evidence suggests that these findings are entirely driven by the selection of healthy employees into wellness programs (Jones et al., 2019).

ductivity from 2003 to 2009. Our analysis differs from these studies along several dimensions. First, we use administrative data that covers the entire population of (Danish) firms and residents. This allows us to both calculate a firm-specific measure of flu severity and include a wide range of control variables such as the number of sick days of top executives. Second, we analyze how the flu affects firm profitability and, importantly, some of the underlying channels for the observed effects. Finally, using balance sheet information at the establishment level allows us to control for unobservable characteristics that vary at the firm-year level.

Finally, our paper contributes to the current public debates on vaccine hesitancy and uptake in the wake of the Covid-19 pandemic. Recent evidence points to a correlation between hesitancy about the Covid-19 vaccine and the flu vaccine, leading to a decline in immunizations against the flu (Leuchter et al., 2022). Our back-of-the-envelope calculation indicates that it would have likely been cost-effective for all but the largest firms in our sample to vaccinate their employees against the flu. While some (large) firms offer immunization opportunities to their employees, our findings suggest that flu vaccine *mandates* could improve firm profitability over the long run.

2 Background

2.1 Sickness benefits and health insurance in Denmark

Employees in Denmark qualify for sickness benefits if they cannot work because of illness. According to the Act on Salaried Employees, they are entitled as a general rule to full pay during sick leave. The wage compensation in sickness is a short-term benefit with a maximum eligibility duration of 52 weeks over 18 calendar months (until 2014) or 22 weeks over 9 calendar months (after 2014).[6] In addition, while there is no general rule, most collective labor agreements and most employment contracts include the right to one or two days of paid leave per sickness spell of a child.

The majority of health care in Denmark is publicly organized and funded. All

[6] Employers are required to pay the sickness benefits for the first 30 calendar days of a sickness spell. Firms can get reimbursed for their sick pay expenses during this period if they are insured or if the sick leave is covered by an agreement with the local authority (municipal government). After the 30th day of sick leave, local authorities cover the payments that relate to the sickness benefits.

Danish residents are assigned a GP who provides their primary care free of charge (i.e., no co-payment), with some exceptions (Pedersen et al., 2005). GPs are the first line of diagnosis and treatment for non-emergent conditions and act as a gatekeeper to specialized care. In addition, more than 45 percent of the population enrolls in voluntary health insurance plans offered by private health insurance companies that reimburse fully or partially the cost of services not included in the national health insurance (Kristensen and Olsen, 2021).

2.2 Seasonal influenza

Seasonal influenza is an acute and contagious respiratory illness caused by influenza viruses. The virus mutates while circulating around the world so previously-obtained immunity is largely lost. Annual outbreaks typically occur during the winter months, when transmission is easier because of low humidity and low temperatures. As a result, the flu is the leading infectious disease in the developed world. Each year, 3–11% of the population are affected with symptoms (Tokars et al., 2018), between 5% and 20% have an asymptomatic version, and 3–5 million cases are severe (e.g., Adda, 2016). In general, the severity of influenza outbreaks varies across years and locations.[7]

Common influenza symptoms are fever, runny nose, cough, headache, muscle and joint pain, and fatigue. Low energy, sleep problems, and reduced ability to concentrate can last for several weeks, leading to substantial absences from work or school. Complications require specialized treatment, but uncomplicated cases typically require only symptom management through care provided by family members. This includes caring for young children, who have the highest risk of contracting the flu and who tend to spread the disease to their caregivers (Jayasundara et al., 2014).

A diagnosis of influenza is made mostly based on symptoms and the likelihood of infection (Krammer et al., 2018). This is complicated by the fact that influenza shares many of its symptoms with other diseases, such as the common cold, and that many patients seek care only when their symptoms are severe. Physicians must then determine if those symptoms result from viral or bacterial infections, typically

[7] Temporal variation is often attributed to changes in virus subtype, vaccine effectiveness, and antiviral treatment. Geographic differences may relate to environmental factors like humidity, temperature, or air pollution. See Dave and Lee (2019) for a review of the literature on seasonal flu patterns.

pneumonia, which would require treatment with antibiotics. A test widely used in primary care in the Nordic countries to distinguish between a viral and a bacterial infection is the C-reactive protein (CRP) test (Melbye et al., 2004).[8] In Denmark, GPs administer CRP tests to more than half of the patients with symptoms of respiratory tract infections during flu seasons (Lykkegaard et al., 2021).[9] As a result, as shown in Appendix Figure A1, the within-year variation in the number of CRP tests tracks closely the variation in hospital admissions for flu and pneumonia and in the incidence rate of influenza-like illness. In conclusion, the administration of a CRP test in primary care can be interpreted as a sign of a severe respiratory tract infection potentially brought on by the flu.

There are two main preventive actions against the flu: good hygiene and vaccination. Flu vaccinations need to be refreshed every year because the virus mutates. Vaccines are on average only 40–60% effective at preventing infection or hospitalization in case of infection among working-age adults (Rondy et al., 2017). In Denmark, vaccinations are free of charge for persons older than 65, people with chronic conditions, and pregnant women in the second or third trimester. The rest of the population needs to pay a fee of about 200 DKK (USD 32) unless they are enrolled in a private health insurance plan, which typically cover 50% of the fee. Despite the relatively low cost, only a small fraction of the population is vaccinated against the flu: According to data from the Danish Ministry of Health, between 2009 and 2015 only around 3% of persons 18–64 years old were vaccinated in each year.[10]

In conclusion, being infected with the flu or having a household member infected with the flu hinders both an employee's ability to go to work and, while at work, their ability to perform their tasks efficiently. In addition, Danish workers are largely unprotected against severe flu seasons given the very low vaccination rate among the working-age population.

[8]CRP is a liver-produced protein involved in the innate immune response, meaning that its blood concentration increases in response to inflammation, infection, or tissue damage. CRP levels are higher in patients with bacterial than with a viral respiratory tract infection (Hopstaken et al., 2003).

[9]The official Danish health authority guidelines recommend that GPs use a CRP test to distinguish between uncomplicated influenza and pneumonia if the patient exhibits (severe) influenza-like symptoms (see https://www.sundhed.dk, last accessed on June 15, 2023).

[10]The data can be found at https://statistik.ssi.dk, last accessed on June 15, 2023.

3 Empirical strategy

We are interested in estimating the effect of employee health on firm performance:

$$\pi_{ikt} = \alpha_t + \nu_i + \widetilde{\beta} \times Employee\_Health_{ikt} + \gamma X_{ikt} + \delta Z_{kt} + \epsilon_{ikt}, \tag{1}$$

where π_{ikt} is a measure of firm-level profitability for firm i located in municipality k in calendar year t, α_t are calendar-year fixed effects, ν_i are firm fixed effects, $Employee\_Health_{ikt}$ is a measure of the general health of the employees in the firm, X_{ikt} denotes firm-level controls, and Z_{kt} denotes municipality-level controls.

The coefficient of interest, $\widetilde{\beta}$, measures the average change in firm performance as a result of a change in the health of its employees. However, it is unlikely that a simple estimation of equation (1) uncovers the causal effect because choices of firms and employees are related to both employee health and firm performance. For example, firms invest in workplace safety when accidents counts are high, which can then reduce their profitability (Cohn and Wardlaw, 2016). At the same time, workers in worse health may choose to work for firms that invest in their employees' health, such as through workplace safety measures. These decisions will result in a spurious positive correlation between the profits of firms and the health of their employees.

To eliminate this potential bias we rely on plausibly exogenous changes in employee health. Large shocks to the health of one or more employees may induce the firm to adjust its workforce, typically by (eventually) replacing the sick employees. The impact of such changes in employee health on firm performance would then be the sum of the direct effect of the health shock and its indirect effect through the workforce adjustment. To isolate the direct effect, we use temporary and relatively small health shocks brought on by the seasonal influenza that do not create incentives for firms to alter their workforce. We measure changes in workforce health through a variable that can be interpreted as a proxy for a respiratory tract infection with severe symptoms, likely brought on by seasonal influenza: the number of CRP tests performed on the employees and their families during the flu season (*CRP_tests*). The estimating equation is then:

$$\pi_{ikt} = \alpha_t + \nu_i + \beta \times CRP\_tests_{ikt} + \gamma X_{ikt} + \delta Z_{kt} + \epsilon_{ikt}, \tag{2}$$

The coefficient of interest β represents the effect on firm performance of an increase in the number of infections with severe symptoms among the firm's workforce and their families. We cluster standard errors at the firm level.

The identifying assumption in this model is that the health shocks due to the flu (as captured by the number of CRP tests) are exogenous to a firm's current financial performance. This assumption is plausible given that most influenza infections happen outside the firm (e.g., Edwards et al., 2016, report that on average only 16.2% of influenza transmission occurs in the workplace), but it would be violated if firms select their location based on their profitability and the (history of the) health of potential employees. We address this concern in several ways. First, we include firm-level controls and firm-fixed effects in our main specification. These should eliminate observable firm characteristics and unobservable (time-invariant) firm characteristics that could factor into the firm's location decision. Second, we estimate specifications with municipality-year fixed effects, which eliminate unobservable characteristics that vary across municipalities *and* years. Finally, in case there might still be some unobserved firm characteristics or municipality characteristics that are correlated with firm-level profitability and local influenza outbreaks, we implement an approach that relies on establishment-level data. For the firms that have more than one establishment (workplace), we estimate a specification similar to Equation (2) but which includes both municipality-year and firm-year fixed effects:

$$\pi_{eikt} = \alpha_{it} + \beta \times CRP\_tests_{eikt} + \gamma X_{eikt} + \delta Z_{kt} + \epsilon_{eikt}, \tag{3}$$

in which the unit of observation is establishment e located in municipality k and belonging to firm i in calendar year t, and the proxy measure *CRP_tests* is calculated at the establishment level. In addition to the municipality-level control variables included in Equation (2), we also include a set of establishment-level controls X_{eikt} and, most importantly, the firm-year fixed effects α_{it}. These variables capture all the time-varying firm-specific drivers of establishment-level profitability and help address the concern that our results are mainly driven by unobservable characteristics of the firm which may vary over time and are not captured by the firm-level controls in Equation (2). We cluster the standard errors at the establishment level.

A second situation in which the identification assumption may be violated is if local influenza outbreaks affect firm performance through changes in local customer demand, which may be the case if ill health reduces personal consumption. We address this in several ways. We include the local unemployment rate or municipality-year fixed effects as control variables in Equations (2) and (3) to capture changes in local customer demand and more generally in local economic activity. We also examine whether firms operating in industries such as manufacturing and construction, which produce durable goods and would arguably not be affected by temporary demand shocks, are impacted less by the temporary health shocks due to the flu.

4 Data

4.1 Data sources and sample selection

Our data come from several administrative registers provided by Statistics Denmark. Each of these registers includes unique firm and/or individual identifiers, which allow us to create very detailed firm-employee matches. We use several registers over the period 1999–2016. The *Population Register* includes variables such as the date of birth, sex, marital status, partner identification number if applicable, and the identification numbers of the parents for every resident of Denmark. The *Health Insurance Register* records the claims made by privately-practicing health professionals to the national health insurance, including the date of the claim and the service provided (but no diagnosis). Given that the national health insurance covers all visits to the GP to which a person is assigned, the register provides the universe of GP visits in Denmark. The *Integrated Database for Labour Market Research Register (IDA)* combines information on employees, such as socioeconomic status or the position in the organization, with information on employers, such as the address of the headquarters or unique identification numbers and addresses for each establishment. This allows us to match employees and firms and to pinpoint the main establishment of firms with multiple workplaces. The position of an employee in the firm is based on the Danish version of the International Standard Classification of Occupations. Information from balance sheets is available in the *Accounting Statistics Register (FIRE)* for all limited liability and public firms that report to the Danish tax authorities. Limited accounting data at the establishment level also exist in the *FIRA Register*, available only between 2007–2015. Finally, the *Municipality Key Figures* is a publicly-available municipality-level data set including aggregate figures such as the unemployment rate, the overall area, and the total population in each each year.

Our sample consists of both privately held and publicly traded firms in Denmark. We include all limited liability firms with more than 10 employees between 1999 and 2016.[11] Following standard conventions in the literature, we exclude all financial, utility, and government-owned entities. Our final sample includes 27,326 firms with a total of 199,123 firm-year observations. Among these firms, we have establishment-level data on 29,850 establishments with 10 or more employees, operating in 20,760 firms over the period 2007–2015, for a total of 161,458 establishment-year observations. As mentioned earlier, the main advantage of the establishment-level data is that we can include firm-by-year fixed effects in our specifications, in which case we restrict the analysis to firms with at least two establishments of at least 10 employees each in the given year. Our preferred establishment-level sample is based on data from 11,959 establishments of 2,464 firms, with a median number of nine establishments per firm, for a total of 52,095 establishment-year observations.

4.2 Variable construction

Similar to prior studies (e.g., Bennedsen et al., 2020; Kulchina, 2016), our main outcomes are two measures of firm profitability: operating return on assets (OROA), defined as the ratio of operating income to total assets, which is not sensitive to (changes to) the firm's capital structure, and the ratio of net income to total assets (NI). We also construct industry-adjusted versions by subtracting their yearly industry-level average at the 4-digit industry level according to the second revision of the Nomenclature of Economic Activities (NACE 2.0), the standard classification of economic activities in the European Community. Data limitations at the establishment level

[11]Specifically, we include firm-years with more than 10 employees so that we have a large enough sample of large enough firms in every year. In addition, we exclude all observations for firms that move headquarters across municipalities at any point during the sample period because this decision might be endogenous to the prevalence of the flu in the original municipality. Our baseline results are robust to not imposing either or both of these constraints.

require us to measure profitability through profit per employee, defined as the ratio of establishment gross profit (in million DKK) to the full-time employee equivalent of the establishment.

We construct our proxy measure *CRP_tests* in several steps. For each firm and each year, we start with the list of its employees. We then add their spouses and children because the treatment of the flu requires supportive care provided by family members and because children tend to spread the disease to their caregivers (see Section 2.2). Finally, we define *CRP_tests* as the average number of CRP tests performed among these people during the flu season.[12] For simplicity, in the rest of the paper we will refer to this measure as "the average number of CRP tests in a firm."

The control variables in our firm-level analysis are a measure of firm size (the natural logarithm of the lagged value of total assets), a measure of industry concentration (the Herfindahl-Hirschmann index of the firm's industry), and indicators for every five-year bin of firm age. We also include the average number of hospitalization days among the top-5 highest-paid employees employees of the firm because of recent evidence of a negative influence on firm performance (Bennedsen et al., 2020), and the average number of hospitalization days among the remaining rank-and-file employees to control for severe shocks to employee health. In the establishment-level analysis, we control for the natural logarithm of establishment-level employment (measured by its full-time employee equivalent) and for the age of the establishment (indicators for every five-year bin). The municipality-level control variables consist of the local unemployment rate and the local population density, both in logarithmic form. We winsorize all variables at the 1% level.

4.3 Descriptive statistics

Table 1 provides the summary statistics. Most of the firms in our sample are small and medium-sized, are spread all over Denmark, and are privately owned. The average (median) firm has 108.0m (14.7m) DKK, or USD 15.8m (2.2m) of total assets, 36

[12] We use billing codes 807120, 81720, 827120, 837120, and 897120 to identify CRP tests performed by GPs. Statens Serum Institut, the Danish equivalent of the Centers for Disease Control and Prevention in the US, monitors the flu between week 40 of a given year and week 20 of the following year. We therefore define the flu season in a given calendar year to include weeks 1–20 and 40–end of the year.

(21) full-time employees, and is 17 (14) years old. Focusing on such smaller firms, which are prevalent in many industrialized countries, implies that our analysis is likely relevant beyond Denmark. Turning to our two measures of firm performance, OROA varies between 0.07% (25th percentile) and 14.1% (75th percentile), with a mean of 6.5%, while NI varies between −2.7% and 9.0% with a mean of 1.9%.

Looking at our measure of flu intensity, we can see that, on average, GPs perform 0.1 CRP tests among the employees of a firm and their family members. Appendix Figure A2 shows that, although there are no CRP tests in about 10% of firm-year observations, there is still substantial variation in the number of CRP tests in a firm. Appendix Figure A3 plots the distribution of the number of CRP tests in a firm in each year and shows that this variation is both cross-sectional and over time. We provide more visual evidence in Appendix Figure A4, which maps the municipality-level average of the number of CRP tests in a firm during a low (2014) and high (2011) flu year. The Figure shows that, in a given year, the firms in some municipalities are hit harder by the flu while others suffer much less, and also that which municipality experiences a more severe flu season may change over time.

Turning to the industry-level characteristics and hospitalization days of employees in Table 1, we can see that the average market concentration in our sample, measured by the Herfindahl-Hirschmann index of the firm's industry sales, is 0.019, indicating that most industries consist of a large number of firms of relatively equal (and small) size. The top-5 employees are hospitalized on average 0.27 days in a year, which is less than rank and file employees (0.40 days) but similar to the number reported by Bennedsen et al. (2020) for a similar sample of Danish firms.

5 Results

5.1 The effect of employee health on firm performance

We first present results based on the empirical model in Equation (2), in which we regress firm-level measures of performance on our proxy for the severity of seasonal influenza. Table 2 reports the effects on our two measures of performance: operating return on assets in Panel A, and the ratio of net income to total assets in Panel B.

Columns (1) and (5) report the estimates from a specification that only includes firm and year fixed effects but no other control variables. We find that both measures of firm-level profitability are significantly lower when employees are exposed to a more severe influenza outbreak. For example, one more CRP test in the firm reduces firm performance as measured by operating return on assets by 0.0188. Given that the average number of CRP tests in a firm is rather low, as shown in Section 4.3, it is more informative to discuss smaller changes than a unit increase in the number of CRP tests. In this section and the rest of the paper, we focus our discussion on the estimated effects of a one standard deviation increase in the number of CRP tests (approximately 0.08 tests). In this case, we find a reduction of the average OROA of approximately 0.15 percentage points, or about 2.33% of the median OROA. Using net income over total assets as a measure of profitability leads to qualitatively similar results, as shown in Panel B. Our coefficient estimate of −0.0185 means that a standard deviation increase in the number of CRP tests in a firm leads to a 0.15 percentage point decline or 5.38% of the median net income in our sample.[13] Overall, our results support the notion that short-term health shocks may reduce employee productivity enough to significantly affect firm-level outcomes such as operating performance.

We add municipality × year fixed effects to our specification in Columns (2) and (6). These fixed effects allow us to control for the impact of all confounding factors that vary across municipalities and over time. In particular, we address the potential concern that our results are not driven by firm-level exposure to local influenza outbreaks but rather by local economic conditions that correlate with local influenza outbreaks. We estimate very similar effects of employee health on firm performance.

Columns (3) and (7) report our preferred specification, which adds the full set of firm and municipality controls to the specification with only firm and year fixed effects in Column (1). Including the average number of hospitalization days of managers and rank-and-file employees addresses the concern that our influenza-related measure of employee health might simply capture CEO hospitalizations, which have been shown to negatively influence firm performance (Bennedsen et al., 2020). The

[13] The median of OROA and NI is more informative than their average because they can take both positive and negative values. Appendix Table A2 shows that we reach qualitatively and quantitatively similar conclusions if we compare our estimated effects to different measures of (variation in) firm profitability.

municipality-level population density and unemployment rate further control for differences in the economic potential and activity in a firm's municipality. It is reassuring that we continue to find a significant negative effect of employee health (measured with the average number of CRP tests in a firm) on firm performance. The estimated reduction in firm performance due to a standard deviation increase in CRP tests is 0.15 percentage points (2.32% of the median) for operating return on assets, and 0.14 percentage points (5.38% of the median) for net income over total assets.

In Columns (4) and (8) we replace our municipality-level control variables with municipality × year fixed effects to again account for all possible local influences on firm-level performance. We confirm our previous conclusions with this specification as all estimated coefficients retain their respective signs, remain statistically significant, and are of similar magnitudes.

Finally, Appendix Table A1 shows the corresponding results using the industry-adjusted versions of our two measures of profitability as outcomes. The estimated effects are qualitatively and quantitatively similar to those in Table 2.[14]

We perform additional robustness tests to address the potential concerns that our results are driven by something other than the impact of influenza on the firm's workforce. Such alternative explanations include persistent (longer-term) effects of severe influenza seasons, the incidence of severe flu seasons during years of economic downturn, the specific role of firms located in the largest and most densely populated municipality in Denmark (Copenhagen), and the choices we make in measuring how the flu affects employee health. For brevity, we describe our robustness analysis in detail in Appendix A2 and Appendix Table A4. Overall, using various sub-samples and alternative measures of exposure to influenza, we continue to find that deteriorating employee health, measured by a firm's exposure to influenza, negatively affects firm profitability.

[14]Given that the industry-adjusted measures have mean zero by construction, we can only compare the magnitude of the estimated coefficient to the standard deviation of the original measure. The effects relative to the standard deviation are quantitatively very similar between the raw and the industry-adjusted measures, as detailed in Appendix Table A2.

5.1.1 The effect of employee health on performance at the establishment level

As a next step, we study the effect of employee health on profitability at the establishment (workplace) level, where we measure profitability as establishment-level profit per employee. Table 3 presents our results. We start in Column (1) by estimating a specification that only includes firm and year fixed effects in the sample of all establishments with at least 10 employees. This yields a negative and statistically significant effect of employee health on establishment-level profitability.

We next leverage the fact that we have information on multiple establishments within the firm for a subset of firms. In the sample of firms with at least two establishments, we can exploit the within-firm geographic variation in the severity of influenza outbreaks across a firm's establishments. Thus, in this setting, we can control for all confounding factors that also vary over time at the firm level by replacing the firm and year fixed effects with firm × year fixed effects.

The estimation results of Equation (3) without establishment-level controls (X_{ekt}), i.e., with only the firm-by-year fixed effects, are shown in Column (2). The estimated effect is much larger and has higher statistical significance than in Column (1), suggesting that unobserved time-varying firm-specific characteristics might cause a bias toward zero. This potential bias works against us and implies that, if anything, we are underestimating in Table 2 the true magnitude of the effect of employee health on performance at the firm level. In Column (3), we further add municipality × year fixed effects, with the municipality given by the establishment's location.[15] These additional fixed effects absorb the influence of any local economic activity at the municipality level. Compared to the results in Column (2), our estimate and its interpretation are not affected by the inclusion of this larger set of fixed effects.

Column (4) presents our preferred specification which, as in Equation (3), includes firm × year fixed effects, establishment-level controls, and municipality-level controls. The coefficient estimate for our measure of employee health becomes even more negative and even more statistically significant. It implies that a one standard deviation increase in the number of CRP tests leads to a decline of 0.82% in our establishment-level measure of profitability relative to its median. While this is

[15] Note that establishment municipalities can differ from the firm's main municipality, which we assigned based on where most of the firm's workforce is located.

slightly lower than the relative effects we documented in Section 5.1 for our firm-level measures of profitability, it is similar to the relative effects in the sample of firms with multiple establishments over the same period (1.19% for OROA, 7.17% for NI). We therefore interpret these results to suggest that our baseline estimates are unlikely to be entirely driven by firm-level characteristics that vary over time and are not captured by our set of firm-specific fixed effects or control variables.

Finally, we again replace our municipality-level controls with municipality $\times$ year fixed effects and present the results of this specification in Column (5). The estimated effect of employee health on establishment-level profitability remains very similar to those previously documented.

5.2 Mechanisms: Labor intensity, financial flexibility, firm size

We first confirm that employee health is related to firm productivity and work absence. Appendix Table A3 shows that, at the firm level, the average number of CRP tests is weakly associated with lower productivity as measured by sales per employee, and that at the region level the average of the number of CRP tests in the firm is strongly associated with employee absences (see Appendix A1 for details).

We next analyze how our main results vary with firm characteristics that are related to firms' reliance on labor (e.g., labor intensity) or with their ability to shift resources to compensate for sick employees, such as financial flexibility and firm size. In all cases, we augment Equation (2) with indicators for firms with those characteristics and their interactions with the average number of CRP tests in the firm. The coefficient estimates are reported in Appendix Tables A5, A6 and A7, while Figure 1 plots the total estimated effects of a one standard deviation increase in the number of CRP tests. Each dot in the Figure represents our point estimate, placed in a 95% confidence interval indicated by the horizontal lines, and the red dashed line is the baseline effect of a one standard deviation increase in the number of CRP tests.

5.2.1 Labor intensity

If employee health affects firm performance through lower employee productivity, we expect labor-intensive firms to be more sensitive to the associated employee health risks than their capital-intensive peers.[16] Confirming our conjecture, the results in Panel A of Figure 1 suggest that our baseline estimate is entirely driven by labor-intensive firms, with capital-intensive firms largely unaffected by the intensity of the flu season. These results are consistent with the idea that the effect operates through an employment productivity channel.

5.2.2 Financial flexibility

Firms could buffer a temporary shock to employee productivity by hiring temporary workers or by employing more capital until sick employees recover. These strategies require a certain degree of financial flexibility. The literature indeed finds that more financially constrained firms report larger spending cuts in labor and capital in the wake of liquidity events (Campello et al., 2010). It is plausible to assume that financial constraints also relate to a firm's ability to manage the more temporary shocks to labor productivity we study in this paper.

We construct a measure of financial constraints following Schauer et al. (2019) and use different cutoffs in the distribution of the measure to define a financially constrained firm, starting from the 50^{th} percentile until the 90^{th} percentile in increments of 5 percentage points.[17] The financial constraints become more binding for the average firm flagged as financially constrained as we increase the threshold.

We report our results in Panel B of Figure 1. If our measure of financial constraints is a good proxy for financial flexibility and such flexibility matters in absorbing health shocks, we would expect the more constrained firms to experience larger effects. Our estimation results support this conjecture: as financial constraints become more binding with higher thresholds in our definition of constrained firms, we observe a more pronounced detrimental effect of employee health shocks on firm performance.

[16] We classify *labor intensive* firm-years as those with above-median wages to revenues (WtR) and below-median total assets to revenues (AtR) ratios, where we calculate these ratios in each year for each firm in our sample. Similarly, we define *capital intensive* firm-years as those with below-median WtR and above-median AtR ratios.

[17] Schauer et al. (2019) propose a measure of financial flexibility calculated as: $\text{flexibility}_{i,t} = -0.123 \times \text{size}_{i,t-1} - 0.024 \times \text{interest coverage}_{i,t-1} - 4.404 \times \text{ROA}_{i,t-1} - 1.716 \times \text{cash holdings}_{i,t-1}$. This measure was specifically developed for private firms, which dominate our sample.

5.2.3 Firm size

Firms may try to mitigate the negative effects of employee sickness by spreading the tasks among healthy employees. Health-induced variation in employee productivity is then more likely to disrupt smaller firms because they may lack the resources to redistribute tasks or to find the talent needed to cover for absent employees. Using a similar approach as in the previous sections, we define several size categories based on the distribution of FTE in our sample and estimate the effect of employee health for each of these subgroups. The results are presented in Panel C of Figure 1.

We start with firms with employment below the median (20.7 FTE) but higher than 10 FTE, the minimum FTE to be included in the sample. Consistent with our conjecture, we find a large, negative, and highly significant overall effect of employee health on firm performance for smaller firms. In contrast, we find no effects for firms with above median employees counts.

We turn next to a finer classification of firms based on the terciles of the distribution of FTE in our sample. *Small firms* (the lowest tercile) have fewer than 16 FTE but more than 10 FTE. *Medium-sized firms* have between 16 and 32 FTE. *Large firms* (the highest tercile) have more than 32 FTE and serve as the baseline. We find large, negative, and statistically significant overall effects of the flu on small and medium-sized firms, while large firms are virtually unaffected. Moreover, the relationship between size and the effect of employee health on both measures of profitability is monotonic, with small firms experiencing larger reductions in response to an influenza outbreak than medium-sized firms. Overall, these findings are again consistent with our conjecture that the smaller firms in our sample are particularly sensitive to a temporary decline in the productivity of their employees.

Finally, in Appendix A3 and Appendix Table A8 we provide complementary evidence at the establishment level. As with firms, small establishments should be more affected by the flu than larger establishments, but less so in larger firms that are better able to shift resources. Indeed, we estimate that the detrimental effect of employee health on firm performance is less pronounced for smaller establishments that are part of larger firms when compared to similar establishments in smaller firms. This finding is consistent with the idea of resource reallocation within larger firms and with the effects being driven by changes in the productivity of employees.

5.3 Economic magnitude

To better assess the economic magnitude of our results, we conduct two types of exercises. First, we ask what is the effect of a "severe flu season," equivalent to a one standard deviation increase in the average number of CRP tests in a firm, on the average firm and the economy.[18] Based on this simple approach, the average firm in our sample experiences a decline of 68,835 DKK (USD 10,949) in yearly operating profits for a one standard deviation increase in the number of CRP tests (see Appendix Table A2). This represents a decline of about 2.33% of the average profit of firms. With a yearly average of 10,218 firms in our sample, covering only firms in the private sector with more than 10 employees, this translates to a total loss in operating profit of approximately 703 million DKK (USD 112 million), or about 0.035% of Denmark's average GDP from 1999 to 2016, which amounts to ca. DKK 2 trillion (USD 320 billion). While not particularly large, this loss is not negligible. For example, it is equivalent to about one tenth of the estimated decline in the GDP of Denmark due to Brexit (European Central Bank, 2020).

A second approach is to ask if it is in the firm's interest to subsidize (and mandate) their employees' out-of-pocket expenses for influenza vaccines. To answer this question, we compare the cost of such a subsidy to the loss reduction that vaccines would provide if every employee receives an immunization. We thus ask how effective vaccines should be so that the estimated profit losses in our data during our sample period are lower than the cost of subsidizing and mandating the vaccination of all employees over the same period. To do so, we define the vaccine *efficacy ratio* as the level of protection against the flu that makes the firm indifferent between subsidizing (and mandating) and not subsidizing the vaccine:

$$\textit{profit reduction} \times \textit{efficacy ratio} = \textit{vaccine program cost}, \tag{4}$$

where *profit reduction* is our estimate of a firm's total influenza-related performance

[18]Since we estimate effects on operating return on assets for our sample firms, we use the average value of assets to convert our estimates into a Danish Kroner value. We use consumer price index data from Statistics Denmark to convert asset values to their 2016 equivalents. We then convert Danish Kroner (DKK) to US Dollars (USD) by applying a single exchange rate of 6.2867 DKK / USD, calculated as the average of yearly average exchange rates (obtained from OFX) between 1999 and 2016.

reduction per year, and *vaccine program cost* measures the firm's total cost of the vaccine program.[19] We compute efficacy ratios for each firm-year and report averages across our panel and for each of the three size groups.

The average efficacy ratio in our sample is 39%, while the median is much lower at around 18%. Given that the flu vaccine is typically about 40–60% effective (Okoli et al., 2021), our results imply that paying for employee vaccinations would likely be cost-effective for both the average and the median firm (see Appendix Table A9). At the lower threshold of 40%, mandatory employee vaccinations are cost-effective in almost 73% of the firm-years in our sample. Analyzing these efficacy ratios in our size-based subsamples leads to results that are consistent with the conclusions in Section 5.2.3. The average (median) efficacy ratio in the group of small firms is 31% (13%), and among medium-sized firms it is 38% (17%). As in the full sample, subsidizing the vaccine for all the employees is cost-effective for 76% of the firm-years among small firms and 73% among medium-sized firms. Vaccine programs are financially unattractive for the largest firms in our sample.[20]

5.4 What makes firms more vulnerable to the flu?

The results in Section 5.2 suggest that a firm's ability to reallocate resources determines how affected it is by an influenza outbreak. Among firms that are equally able to shift resources, which characteristics would make some more vulnerable when their employees are sick? To answer this question, we examine two features that can modulate the effect of employee health on firm performance: the industry in which the firm operates and the characteristics of its workforce. As in Section 5.2, we report the coefficient estimates in Appendix Tables A10 and A11 and plot the effects of a standard deviation increase in CRP tests in Figure 2.

[19]The profit reduction is calculated by multiplying the estimated effect of the number of CRP tests in a firm by the actual number of CRP tests and by the value of total assets. The cost is the number of FTEs multiplied by the out-of-pocket cost of a vaccine in Denmark, 200 DKK (USD 32).

[20]We reach similar conclusions with an analysis at the firm level, in which case we average the yearly efficacy ratios for each firm. Fully subsidizing and mandating flu vaccines is cost-effective for nearly 61% of the firms in our sample, while the fraction stands at almost 70% among small firms and almost 65% among medium-sized firms.

5.4.1 Industry

The nature of job tasks varies across industries and can make workers within a firm more complementary or more substitutable. Worker absences can have a more pronounced impact in firms/industries where coworkers rely on each other to fulfill their tasks than in firms/industries where they can substitute for each other more easily. Previous research also found that the sensitivity of worker productivity to influenza varies by industry (e.g., Suarthana et al., 2010). We examine whether such differences exist between the retail/wholesale and manufacturing/construction industries. Although employees in retail/wholesale face increased risks for infection due to their exposure to the general public (Luckhaupt et al., 2012), finding temporary substitutes or compensating for employee absences without significantly affecting productivity or output may be more feasible in these industries. On the contrary, the nature of manufacturing/construction with strict schedules and sequential deadlines may cause projects to fall behind schedule if employee absenteeism increases, which may affect firm profitability more (Salehi Sichani et al., 2011). In addition, retail profits may be mostly driven by local demand, while manufacturing profitability is likely driven to a much larger extent by non-local demand. As such, the detrimental effect of a flu outbreak on manufacturing/construction firm performance is more likely to be due to a reduction in employee productivity rather than to changes in local demand.

To implement our analysis, we categorize firms using the NACE 2.0 classification. We construct indicator variables for firms in wholesale/retail (NACE 45 and 47) and manufacturing/construction (NACE 10–33 and 41–43) and augment the specification in Equation (2) with these indicators and their interactions with the average number of CRP tests in the firm. Panel A of Figure 2 reports the estimated effect of a one standard deviation increase in the number of CRP tests on firm-level profitability measures, similar to Figure 1. We find no meaningful impact of employee health on firm performance in the wholesale/retail industries, a finding that is consistent across our two profitability measures. In contrast, we find a pronounced negative effect in the manufacturing/construction industries.

Taken together, these results confirm our hypothesis that firms that operate in less flexible industries, in which it is more difficult to cover for sick employees, are more affected by shocks to their employees' health. They also support our interpretation that the effect of the flu is more likely to operate through changes in employee productivity rather than through changes in local demand.

5.4.2 Workforce characteristics

Vulnerability and resilience to health shocks also vary in the population. In the context of our study, we expect to see a stronger effect of influenza outbreaks on performance among firms with similar reliance on labor when employees are more vulnerable to the flu. We proxy for vulnerability with several workforce characteristics: wages, skill, education, age, and the presence of children in a household. Employees who earn higher salaries, are employed in high-skilled occupations, or with college education should have a better health stock and thus to be more resilient to health shocks such as influenza infections. As age affects sensitivity to the flu in a nonlinear way, we form three age groups for our analysis: persons younger than 35, between 35 and 55, or older than 55. Last, we separate households with and without children under 10 because these children likely require care by an adult when ill. While young children generally increase an employee's exposure to adverse health shocks, the marginal effect of a severe flu shock might be negligible because such households are regularly exposed to seasonal illnesses during the winter months.

We construct our proxy for employee health shocks, *CRP_tests*, among employees with these characteristics within a firm and we include these variables in our baseline specification.[21] Panel B of Figure 2 reports the estimated effect of a one standard deviation increase in the number of CRP tests on firm-level profitability measures.

Starting our discussion with salary, skill, and education, we find that adverse health shocks primarily reduce firm profitability if they affect low-salary, low-skill, and low-education employees. Most of our negative coefficient estimates are larger in magnitude and statistically significant for these groups of employees. Our findings suggest that firm profitability is sensitive to health shocks experienced not only by CEOs, as recently documented by Bennedsen et al. (2020), but also by more vulnerable "lower-level," rank-and-file employees.

Turning to employee age and family status, we find that sickness of employees

[21] We also include industry fixed effects to account for time-invariant sector-specific workforce characteristics, as well as the yearly fraction of each firm's workforce that belongs to each relevant category.

aged 35–54 exerts the strongest effect on firm profitability. These persons are more likely to have older children who do not need so much adult care when ill, and they are also young enough to not be at high risk of complications from the flu. Therefore, these employees are the ones most likely to experience unexpected changes in health and productivity during a more severe flu season, and hence the ones more likely to negatively affect firm performance. This explanation is reinforced when we distinguish between employees with and without young children. Firm performance is only negatively affected by health shocks to employees without young children, who are the persons most likely to experience unexpected (or larger) changes in health between low and high flu seasons.

5.5 Effects on workforce and firm owners

In this last section, we analyze whether firms in our sample fully absorb employee health risks or whether these risks are, at least partially, borne by their employees. To the extent that seasonal influenza is a temporary health shock, we expect to see firms shelter their employees from most of the associated negative financial implications (see Guiso et al., 2005). Given the gradient in the effects of employee health on firm performance by firm size, we estimate specifications similar to those in Appendix Table A7, in which we include the average number of CRP tests in a firm and its interaction with a below-median size indicator to capture differential responses between larger and smaller firms in our sample.

5.5.1 Effects on firm workforce

We start by verifying that the relationship between firm size and the effect of the flu on firm performance is mediated through worker productivity. As in Appendix A1, we use sales-per-employee as a proxy for employee productivity. Column (1) of Table 4 shows that shocks to employee health do not have a detrimental effect on worker productivity in large firms. In contrast, more CRP tests lead to a statistically significant decline in worker productivity in smaller firms: the total effect of an additional CRP test (the sum of the baseline coefficient and the interaction term) is negative and significant. These results are consistent with those on firm-level profitability in Appendix Table A7. It is indeed the smaller firms for which we observe a larger decline in profitability, which can then be traced to a reduction in worker productivity.

Moving to outcomes for workers, we provide similar evidence for employment and wages in Columns (2) and (3).[22] We find no negative effects in large firms but a negative and statistically significant, albeit small, total effect in small firms in both regressions. A one standard deviation increase in the number of CRP tests in smaller firms results in a reduction in employment of 0.11% or 0.03 FTE and a decline in average wages per worker of 0.01% or DKK 29 (USD 4.50).

Overall, our results suggest that even the smaller firms in our sample shield their workforce from much of the temporary loss in profitability that they experience during a severe influenza season. Although the reductions in employment and wages among smaller firms are statistically significant, they are economically insignificant.

5.5.2 Effects on firm owners

We next ask how firms absorb the labor risk stemming from variations in employee health. We first examine this question by considering firm-level cash positions. The estimates in Column (4) of Table 4 show that smaller firms do not choose to draw down cash in response to a higher average number of CRP tests. On the contrary, the total effect is positive and significant. On average, we find that smaller firms increase their cash by 0.37% in response to a one standard deviation increase in the average number of CRP tests in a firm. Larger firms, on the other hand, tap into their cash reserves as they experience more influenza cases in their workforce. The estimated coefficient corresponds to a decline in cash of 1.65% for a one standard deviation increase in the average number of CRP tests in a firm. This is consistent with large firms, but not small firms, being able to shift resources (from cash to workforce) to cover for sick employees and minimize the effect on firm profitability.

Relatedly, in Column (5), we examine the likelihood of firms incurring expenses for temporary workers. We find that an increase in the number of CRP tests reduces the likelihood of larger firms to incur expenses for temporary workers. Smaller firms, on the other hand, are more inclined to hire temporary workers (the total effect of

[22]Average wages are calculated based on the set of workers who have been with the firm during the previous year. Thus, the measure is not contaminated by changes in workforce composition.

an additional CRP test in the firm is positive and significant). One possible interpretation for this pattern is that larger firms are better positioned to apply cost-saving measures such as reducing temporary labor costs when facing a shock to employee health. Smaller firms may need to compensate for the average productivity decline of their employees by hiring temporary workers, which in turn may contribute to the downward pressure on firm-level profitability.

Finally, we examine the effect of employee health on dividends. Large firms do not adjust their dividend payments when the average number of CRP tests in a firm increases, as evidenced by the insignificant baseline coefficient in Column (6). Smaller firms, however, reduce their dividends: the total effect of a one standard deviation increase in the average number of CRP tests in the firm is a cut of 1.44% in dividends.

6 Conclusion

In this paper, we study how changes in employee health resulting from temporary and relatively mild health shocks influence firm operating performance. The specific health shock we exploit is the variation in the severity of flu seasons in Denmark. Using detailed administrative data, we use medical tests conducted by GPs to identify changes in the number of persons with symptoms of a severe upper respiratory tract infection, likely as the result of influenza and its main complication, pneumonia, and use that to proxy for the severity of the influenza season.

We find that firms are negatively affected in years in which they experience a particularly severe flu season. A one standard deviation increase in the number of CRP tests in a firm reduces the median operating return on assets by approximately 2.3%. These effects are more pronounced for labor-intensive, small, and financially constrained firms. The level of detail of our data allows us to further study how employee health affects establishment-level operating performance. The advantage of this approach is that we can include firm-by-year fixed effects to account for time-varying unobservable variables at the firm level. We obtain similar results with this alternative regression specification, and our estimates for the impact of employee health on establishment performance are consistently negative and significant. As a last step, we analyze how health shocks are absorbed within the firm and focus on employees and shareholders. We find that firms do not substantially adjust wages and employment. However, we find that smaller firms increase their cash holdings, are more inclined to hire temporary workers, and reduce their dividend payments. Owners of larger firms are not meaningfully affected by deteriorating employee health.

Our back-of-the-envelope calculations suggest that firms, especially smaller ones, may have the incentive to subsidize and mandate the immunization of their employees against the flu. This is a particularly important result given the prevalence of the flu and the debate around vaccines in respiratory viral infections spurred by the recent COVID-19 pandemic.

References

Adda, Jérôme. 2016. "Economic Activity and the Spread of Viral Diseases: Evidence from High Frequency Data." *Quarterly Journal of Economics* 131 (2): 891–941.

Akazawa, Manabu, Jody L. Sindelar, and A. David Paltiel. 2003. "Economic Costs of Influenza-Related Work Absenteeism." *Value in Health* 6 (2): 107–115.

Allayannis, George, Jane Ihrig, and James P Weston. 2001. "Exchange-Rate Hedging: Financial versus Operational Strategies." *American Economic Review* 91 (2): 391–395.

Almeida, Heitor, Kristine Watson Hankins, and Ryan Williams. 2017. "Risk Management with Supply Contracts." *Review of Financial Studies* 30 (12): 4179–4215.

Autor, David H., Mark Duggan, Kyle Greenberg, and David S. Lyle. 2016. "The Impact of Disability Benefits on Labor Supply: Evidence from the VA's Disability Compensation Program." *American Economic Journal: Applied Economics* 8 (3): 31–68.

Baicker, Katherine, David Cutler, and Zirui Song. 2010. "Workplace Wellness Programs Can Generate Savings." *Health Affairs* 29 (2): 304–311.

Bennedsen, Morten, Francisco Pérez-Gonzàlez, and Daniel Wolfenzon. 2020. "Do CEOs matter? Evidence from Hospitalization Events." *Journal of Finance* 75 (4): 1877–1911.

Bennedsen, Morten, Margarita Tsoutsoura, and Daniel Wolfenzon. 2019. “Drivers of Effort: Evidence from Employee Absenteeism.” *Journal of Financial Economics* 133 (3): 658–684.

Bradley, Cathy J., Heather L. Bednarek, and David Neumark. 2002. “Breast Cancer Survival, Work, and Earnings.” *Journal of Health Economics* 21 (5): 757–779.

———. 2005. “Short-Term Effects of Breast Cancer on Labor Market Attachment: Results from a Longitudinal Study.” *Journal of Health Economics* 24 (1): 137–160.

Buck Consultants. 2018. “Working Well: A Global Survey of Workforce Wellbeing Strategies.”

Campello, Murillo, John R. Graham, and Campbell R. Harvey. 2010. “The Real Effects of Financial Constraints: Evidence from a Financial Crisis.” *Journal of Financial Economics* 97 (3): 470–487.

Cohn, Jonathan B., and Malcolm I. Wardlaw. 2016. “Financing Constraints and Workplace Safety.” *Journal of Finance* 71 (5): 2017–2058.

Dave, Kunjal, and Patricia C. Lee. 2019. “Global Geographical and Temporal Patterns of Seasonal Influenza and Associated Climatic Factors.” *Epidemiologic Reviews* 41 (1): 51–68.

Dorner, Matthias, and Peter Haller. 2020. “Not Coming in Today — Firm Productivity Differentials and the Epidemiology of the Flu.” IAB-Discussion Paper No. 6/2020.

Eccles, Ron. 2005. “Understanding the Symptoms of the Common Cold and Influenza.” *Lancet Infectious Diseases* 5 (11): 718–725.

Edwards, Christina H., Gianpaolo S. Tomba, and Birgitte F. de Blasio. 2016. “Influenza in Workplaces: Transmission, Workers’ Adherence to Sick Leave Advice and European Sick Leave Recommendations.” *European Journal of Public Health* 26 (3): 478–485.

Edwards, Paul, and Kay Greasley. 2010. “Absence from Work.” European Foundation for the Improvement of Living and Working Conditions.

European Central Bank. 2020. “A Review of Economic Analyses on the Potential Impact of Brexit.” Available: `https://data.europa.eu/doi/10.2866/977526`.

Falato, Antonio, Dan Li, and Todd Milbourn. 2015. "Which Skills Matter in the Market for CEOs? Evidence from Pay for CEO Credentials." *Management Science* 61 (12): 2845–2869.

García-Gómez, Pilar, Hans van Kippersluis, Owen O'Donnell, and Eddy van Doorslaer. 2013. "Long-Term and Spillover Effects of Health Shocks on Employment and Income." *Journal of Human Resources* 48 (4): 873–909.

Grinza, Elena, and François Rycx. 2020. "The Impact of Sickness Absenteeism on Firm Productivity: New Evidence from Belgian Matched Employer-Employee Panel Data." *Industrial Relations: A Journal of Economy and Society* 59 (1): 150–194.

Grossman, Michael. 1972. "On the Concept of Health Capital and the Demand for Health." *Journal of Political Economy* 80 (2): 223–255.

Guiso, Luigi, Luigi Pistaferri, and Fabiano Schivardi. 2005. "Insurance within the Firm." *Journal of Political Economy* 113 (5): 1054–1087.

Hopstaken, R. M., J. W. Muris, J. A. Knottnerus, A. D. Kester, P. E. Rinkens, and G. J. Dinant. 2003. "Contributions of Symptoms, Signs, Erythrocyte Sedimentation Rate, and C-Reactive Protein to a Diagnosis of Pneumonia in Acute Lower Respiratory Tract Infection." *British Journal of General Practice* 53 (490): 358–364.

Humlum, Anders, and Jakob R. Munch. 2023. "Globalization, Flexicurity and Adult Vocational Training in Denmark." Edited by Marc Bacchetta, Emmanuel Milet, and José-Antonio Monteiro. In *Making Globalization More Inclusive: Lessons from Experience with Adjustment Policies*. World Trade Organization.

Jayasundara, Kavisha, Charlene Soobiah, Edward Thommes, Andrea C. Tricco, and Ayman Chit. 2014. "Natural Attack Rate of Influenza in Unvaccinated Children and Adults: A Meta-Regression Analysis." *BMC Infectious Diseases* 14 (1): 670.

Jenter, Dirk, Thomas Schmid, and Daniel Urban. 2023. "Does Board Size Matter?" Working Paper, Available at SSRN: http://dx.doi.org/10.2139/ssrn.4371743.

Jones, Damon, David Molitor, and Julian Reif. 2019. “What Do Workplace Wellness Programs Do? Evidence from the Illinois Workplace Wellness Study.” *Quarterly Journal of Economics* 134 (4): 1747–1791.

Keech, Martin, and Paul Beardsworth. 2008. “The Impact of Influenza on Working Days Lost: A Review of the Literature.” *PharmacoEconomics* 26 (11): 911–924.

Kostøl, Andreas, Magne Mogstad, Bradley Setzler, et al. 2019. “Disability Benefits, Consumption Insurance, and Household Labor Supply.” *American Economic Review* 109 (7): 2613–54.

Krammer, Florian, Gavin J. D. Smith, Ron A. M. Fouchier, Malik Peiris, Katherine Kedzierska, Peter C. Doherty, Peter Palese, et al. 2018. “Influenza.” *Nature Reviews. Disease Primers* 4 (1): 3.

Kreiner, Claus Thustrup, and Michael Svarer. 2022. “Danish Flexicurity: Rights and Duties.” *Journal of Economic Perspectives* 36 (4): 81–102.

Kristensen, Søren Rud, and Kim Rose Olsen. 2021. “Sustainable Health Care and Health Care Reforms in Denmark 2000–2020.” In *The Sustainability of Health Care Systems in Europe*. Emerald Publishing Limited.

Kulchania, Manoj, and Shawn Thomas. 2017. “Cash Reserves as a Hedge Against Supply-Chain Risk.” *Journal of Financial and Quantitative Analysis* 52 (5): 1951–1988.

Kulchina, Elena. 2016. “Personal Preferences, Entrepreneurs’ Location Choices, and Firm Performance.” *Management Science* 62 (6): 1814–1829.

Leuchter, Richard K., Nicholas J. Jackson, John N. Mafi, and Catherine A. Sarkisian. 2022. “Association between Covid-19 Vaccination and Influenza Vaccination Rates.” *New England Journal of Medicine* 386 (26): 2531–2532.

Luckhaupt, Sara E., Marie Haring Sweeney, Renee Funk, Geoffrey M. Calvert, Mackenzie Nowell, Tiffany D’Mello, Arthur Reingold, James Meek, Kimberly Yousey-Hindes, Kathryn E. Arnold, et al. 2012. “Influenza-Associated Hospitalizations by Industry, 2009–10 Influenza Season, United States.” *Emerging Infectious Diseases* 18 (4): 556.

Lykkegaard, Jesper, Jonas Kanstrup Olsen, Rikke Vognbjerg Sydenham, and Malene Plejdrup Hansen. 2021. "C-Reactive Protein Cut-Offs Used for Acute Respiratory Infections in Danish General Practice." *BJGP Open* 5 (1).

Melbye, Hasse, Dag Hvidsten, Arne Holm, Sveine Arne Nordbø, and Jan Brox. 2004. "The Course of C-Reactive Protein Response in Untreated Upper Respiratory Tract Infection." *British Journal of General Practice* 54 (506): 653–658.

Morris, Landi, and Rani Hoitash. 2021. "Working with the Flu: The Association Between Auditor Health and Audit Outcomes." Working Paper, Available at SSRN: http://dx.doi.org/10.2139/ssrn.3231579.

Okoli, G. N., F. Racovitan, T. Abdulwahid, C. H. Righolt, and S. M. Mahmud. 2021. "Variable Seasonal Influenza Vaccine Effectiveness across Geographical Regions, Age Groups and Levels of Vaccine Antigenic Similarity with Circulating Virus Strains: A Systematic Review and Meta-Analysis of the Evidence from Test-Negative Design Studies after the 2009/10 Influenza Pandemic." *Vaccine* 39 (8): 1225–1240.

Peasah, Samuel K, Eduardo Azziz-Baumgartner, Joseph Breese, Martin I Meltzer, and Marc-Alain Widdowson. 2013. "Influenza Cost and Cost-Effectiveness Studies Globally—A Review." *Vaccine* 31 (46): 5339–5348.

Pedersen, Kjeld Møller, Terkel Christiansen, and Mickael Bech. 2005. "The Danish Health Care System: Evolution - Not Revolution - in a Decentralized System." *Health Economics* 14 (S1): S41–S57.

Pérez-González, Francisco, and Hayong Yun. 2013. "Risk Management and Firm Value: Evidence from Weather Derivatives." *Journal of Finance* 68 (5): 2143–2176.

Putri, Wayan C.W.S., David J. Muscatello, Melissa S. Stockwell, and Anthony T. Newall. 2018. "Economic Burden of Seasonal Influenza in the United States." *Vaccine* 36 (27): 3960–3966.

Rondy, Marc, Nathalie El Omeiri, Mark G. Thompson, Alain Levêque, Alain Moren, and Sheena G. Sullivan. 2017. "Effectiveness of Influenza Vaccines in Preventing Severe Influenza Illness among Adults: A Systematic Review and Meta-Analysis of Test-Negative Design Case-Control Studies." *Journal of Infection* 75 (5): 381–394.

Salehi Sichani, Mahdi, SangHyun Lee, and Aminah Robinson Fayek. 2011. "Understanding Construction Workforce Absenteeism in Industrial Construction." *Canadian Journal of Civil Engineering* 38 (8): 849–858.

Schauer, Catharina, Ralf Elsas, and Nikolas Breitkopf. 2019. "A New Measure of Financial Constraints Applicable to Private and Public Firms." *Journal of Banking & Finance* 101:270–295.

Schopp, Anne, and Karsten Neuhoff. 2013. "The Role of Hedging in Carbon Markets." *Discussion Papers of DIW Berlin*, no. 1271.

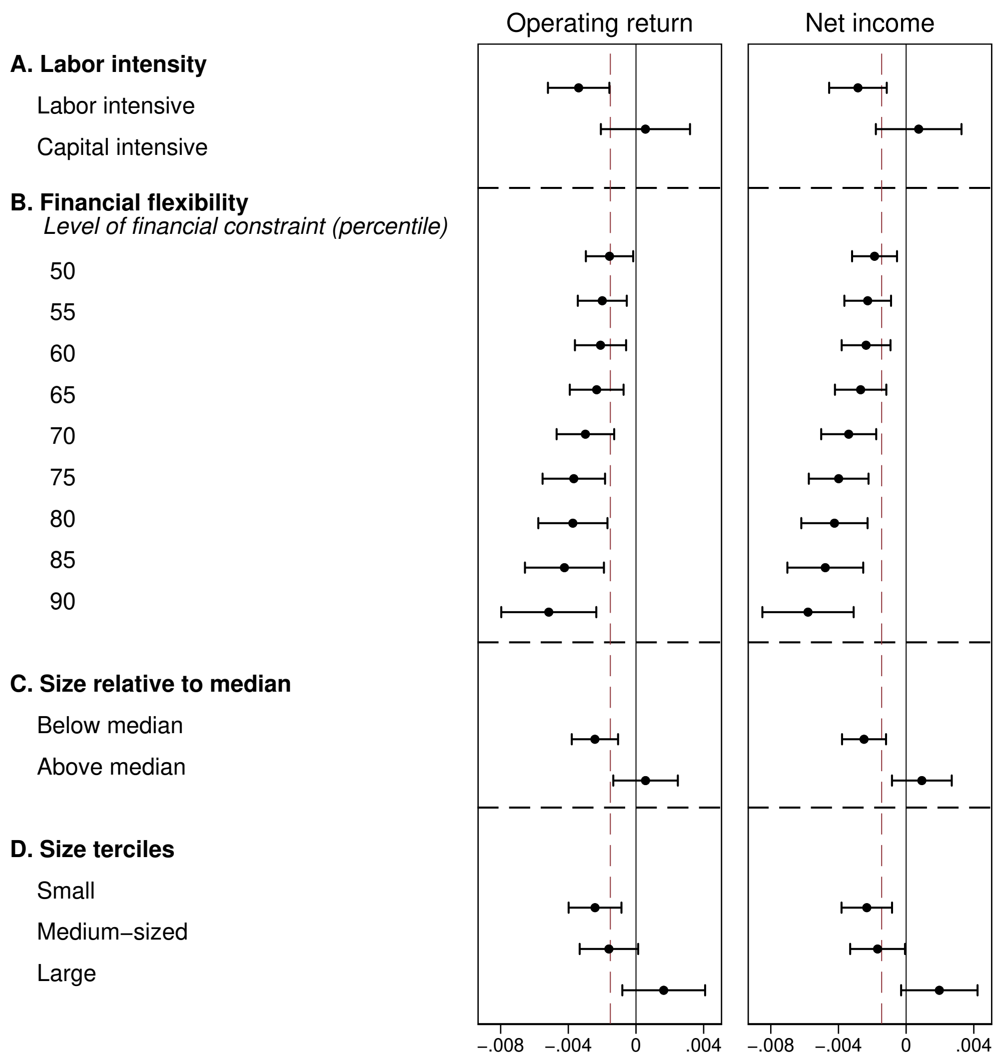
Schwandt, Hannes. 2019. "The Lasting Legacy of Seasonal Influenza: In-Utero Exposure and Labor Market Outcomes." CEPR Discussion Paper No. 12563.

Smith, James P. 1999. "Healthy Bodies and Thick Wallets: The Dual Relation Between Health and Economic Status." *Journal of Economic Perspectives* 13 (2): 145–166.

Stulz, René M. 1996. "Rethinking Risk Management." *Journal of Applied Corporate Finance* 9 (3): 8–25.

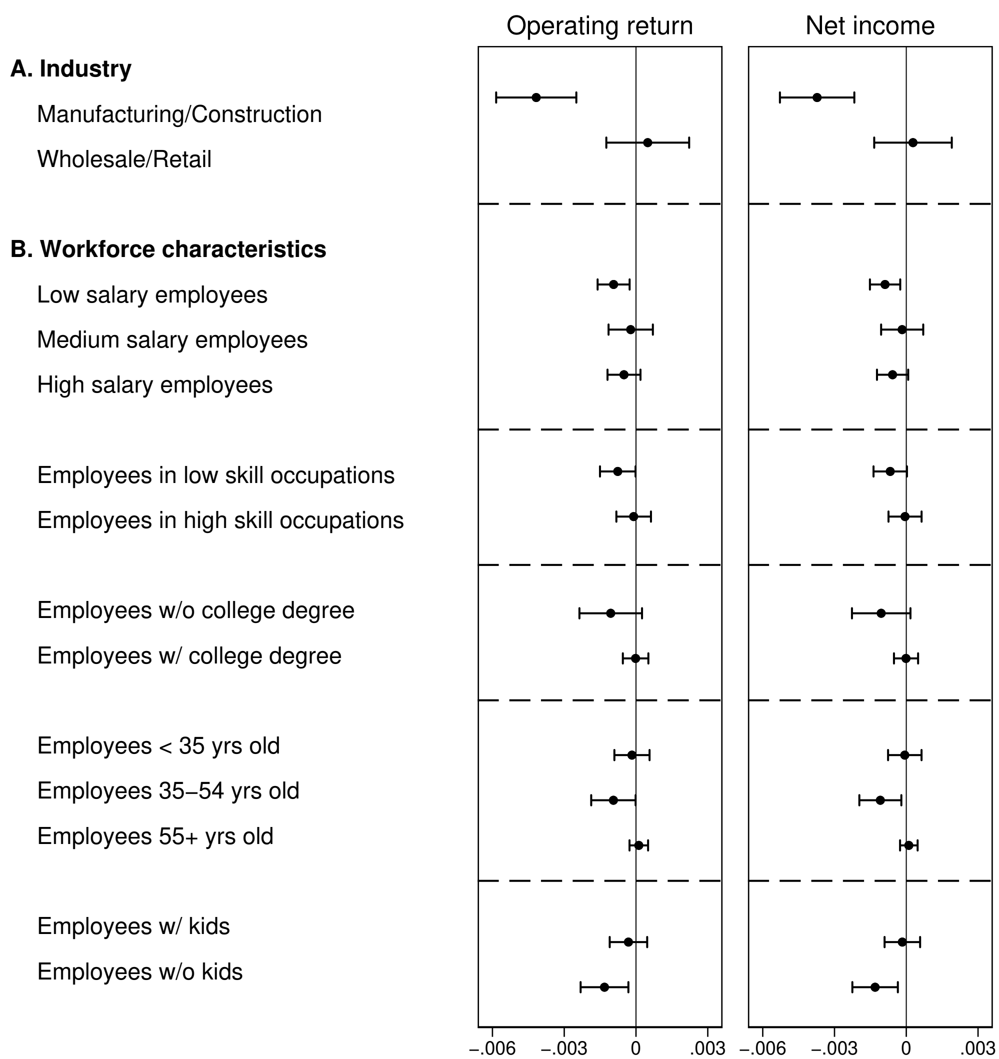
Suarthana, Eva, J.D. McFadden, A.S. Laney, K. Kreiss, H.A. Anderson, D.C. Hunt, D. Neises, K. Goodin, A. Thomas, M. Vandermeer, et al. 2010. "Occupational Distribution of Persons with Confirmed 2009 H1N1 Influenza." *Journal of Occupational and Environmental Medicine* 52 (12): 1212–1216.

Tokars, Jerome I., Sonja J. Olsen, and Carrie Reed. 2018. "Seasonal Incidence of Symptomatic Influenza in the United States." *Clinical Infectious Diseases* 66 (10): 1511–1518.



Notes: Each dot represents the total estimated effect (i.e., the sum of the baseline and eventual interaction coefficients) of a one standard deviation increase in the number of CRP tests for the firms with the characteristic indicated in the row, while the line segments plot the corresponding 95% confidence intervals. The horizontal dashed lines separate the different specifications, while the vertical red dashed line indicates the baseline effect of a one standard deviation increase in the number of CRP tests. The estimation results are reported in Appendix Tables A5, A6 and A7.

Figure 1: Heterogeneous Effects by Labor Intensity, Financial Flexibility, and Firm Size



Notes: Each dot represents the total estimated effect (i.e., the sum of the baseline and eventual interaction coefficients) of a one standard deviation increase in the number of CRP tests for the firms with the characteristic indicated in the row or among employees with the characteristic indicated in the row, while the line segments plot the corresponding 95% confidence intervals. The horizontal dashed lines separate the different specifications. The estimation results are reported in Appendix Tables A10 and A11.

Figure 2: Heterogeneous Effects by Industry and Workforce Characteristics

Table 1: Summary Statistics

This table presents the summary statistics for nonfinancial, nonutility, and nongovernment-owned firms in Denmark between 1999 and 2016 with 10 or more employees. Operating return on assets (OROA) is the ratio of operating income to total assets, and net income (NI) is the ratio of income to total assets. CRP tests are the number of CRP tests performed on employees and their families during the flu season. Market concentration (HHI), measured by the Herfindahl-Hirschmann index of the firm's industry; N days at hospital (avg)—Top-5 employee / Rank and file employee, is the average number of days a top-5/ non-top-5 employee was hospitalized in a given year; Population density / Unemployment rate, the population density of / unemployment rate in the firm's municipality. All variables are winsorized at the 1% level.

	Mean	Std. dev.	1%	25%	50%	75%	99%
Dependent variables:							
— Operating return on assets (OROA)	0.065	0.183	−0.676	0.007	0.065	0.141	0.534
— Net income (NI)	0.019	0.170	−0.726	−0.027	0.027	0.090	0.409
Main independent variable:							
— CRP tests	0.104	0.079	0.000	0.043	0.091	0.149	0.344
Firm characteristics:							
— Log(Assets)	9.754	1.233	7.382	8.876	9.597	10.472	12.664
— Full-time employees	35.546	36.962	10.080	13.760	20.690	38.040	159.110
— Firm age (years)	17.081	13.490	1.000	7.000	14.000	24.000	68.000
Industry characteristics:							
— Market concentration (HHI)	0.019	0.041	0.002	0.004	0.008	0.017	0.235
Local (municipality) characteristics:							
— Local population density (municipality)	5.480	1.515	3.657	4.278	4.960	6.444	8.901
— Local unemployment rate (municipality)	0.040	0.014	0.012	0.030	0.040	0.050	0.075
Hospital days (avg):							
— Top-5 employee, N days at hospital	0.274	0.743	0.000	0.000	0.000	0.200	4.600
— Rank and file employee, N days at hospital	0.396	0.534	0.000	0.083	0.250	0.494	3.059

Table 2: The Effect of Employee Health on Firm Performance
This table examines the effect of employee health on firm operating performance. In Panel A, the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets. In Panel B, the dependent variable is net income to total assets (NI). To measure employee health, we examine the number of CRP tests performed on employees and their families during the flu season. Firm controls include Log(Assets), the natural logarithm of the lagged value of total assets; Market concentration (HHI), measured by the Herfindahl-Hirschmann index of the firm's industry; N days at hospital (avg) — Top-5 employee / Rank and file employee, the average number of days a top-5 / non-top-5 employee was hospitalized in a given year; Local controls (municipality) — Population density / Unemployment rate, the population density of / unemployment rate in the firm's municipality. All variables are winsorized at the 1% level and all specifications focus on firms with at least ten employees and include firm fixed effects. Columns (1) and (3) also include year fixed effects while Columns (2) and (4) use municipality times year fixed effects. Columns (3) and (4) further include firm age dummies for every five-year bin of firm age. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: OROA				Panel B: Net Income			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CRP tests	−0.0188**	−0.0161**	−0.0191**	−0.0167**	−0.0185**	−0.0165**	−0.0182**	−0.0169**
	(0.0077)	(0.0078)	(0.0078)	(0.0080)	(0.0073)	(0.0074)	(0.0074)	(0.0075)
Log(Assets)			−0.0114***	−0.0115***			−0.0098***	−0.0098***
			(0.0013)	(0.0013)			(0.0012)	(0.0012)
Market concentration (HHI)			0.0009	0.0041			0.0092	0.0119
			(0.0137)	(0.0139)			(0.0133)	(0.0133)
Top-5 employee, N days at hospital (avg)			−0.0014***	−0.0015***			−0.0010**	−0.0011**
			(0.0005)	(0.0005)			(0.0005)	(0.0005)
Rank and file employee, N days at hospital (avg)			−0.0010	−0.0010			−0.0010	−0.0010
			(0.0007)	(0.0007)			(0.0007)	(0.0007)
Municipality density			0.0166				0.0269	
			(0.0197)				(0.0183)	
Unemployment rate			−0.3194***				−0.2257***	
			(0.0900)				(0.0834)	
Controls	No	No	Yes	Yes	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892	194,073	194,050	183,917	183,892
R^2	0.343	0.344	0.347	0.347	0.325	0.325	0.327	0.327

Table 3: The Effect of Employee Health on Establishment-Level Performance
This table shows the effect of employee health on establishment operating performance. The dependent variable is *Profit per employee*, the ratio of establishment gross profit (in DKK) to the full-time employee equivalent of the establishment. To measure employee health, we examine the number of CRP tests performed on the employees and their families during the flu season, at the establishment level. Establishment and local controls on the municipality level include *Size*, the natural logarithm of the lagged value of the full-time employee equivalent of the establishment; *Population density* and *Unemployment rate*, the population density of, and unemployment rate in the establishment's municipality, respectively. All variables are winsorized at the 1% level. In Column (1), we include firm and year fixed effects. In Columns (2)–(5), we use firm-year fixed effects instead of firm and year fixed effects. In Columns (4) and (5), we add establishment-level age fixed effects for every five-year bin of establishment age. Clustered (establishment) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Profit per employee				
	(1)	(2)	(3)	(4)	(5)
CRP tests	−0.0436*	−0.0758**	−0.0812**	−0.0931***	−0.1011***
	(0.0225)	(0.0352)	(0.0347)	(0.0358)	(0.0353)
Size				0.0021	0.0030
				(0.0053)	(0.0053)
Municipality density				−0.0004	
				(0.0027)	
Unemployment rate				−0.1832	
				(0.4960)	
Controls	No	No	No	Yes	Yes
Fixed effects	Firm and year	Firm x year	Firm x year and muni x year	Firm x year	Firm x year and muni x year
N	161,458	52,095	52,078	49,976	49,959
R^2	0.656	0.834	0.834	0.826	0.826

Table 4: The Effect of Employee Health on Workforce and Firm Owners

This table shows how employee health affects the firm's workforce and owners. Columns (1) to (3) present results for workers. We measure worker outcomes in several ways. The ratio of log sales over the number of employees is our measure of productivity. We capture total workforce size and salaries with the natural logarithm of full-time equivalent employment and the natural logarithm of average yearly wages. In Column (4), the dependent variable, Cash, is the ratio of cash holdings to total assets, and in Column (5) it is a dummy variable that is equal to one if a firm has expenses for temporary employment, and zero otherwise. In Column (6), Dividends are the ratio of dividends to total assets. All variables are winsorized at the 1% level. We use the distribution of full-time equivalent employment (FTE) to classify firms as above or below the median. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Worker			Firm		Owner
	Productivity (1)	Employment (2)	Wages (3)	Cash (4)	Temp. Labor Dummy (5)	Dividends (6)
CRP tests	0.1593***	0.1098***	0.0467***	−0.0169**	−0.1188***	0.0031
	(0.0250)	(0.0231)	(0.0138)	(0.0068)	(0.0361)	(0.0050)
CRP tests × below median	−0.2295***	−0.1540***	−0.0642***	0.0216***	0.2067***	−0.0117**
	(0.0289)	(0.0264)	(0.0159)	(0.0075)	(0.0381)	(0.0054)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,802	183,918	183,043	183,917	183,918	183,917
R^2	0.848	0.935	0.874	0.442	0.155	0.324

Employee health and firm performance

Online Appendix

Daniel Rettl
University of Georgia

Alexander Schandlbauer
University of Southern Denmark

Mircea Trandafir
Rockwool Foundation Research Unit and IZA

A1 The relationship between employee health and employee performance

In this section, we confirm that employee health is related to their productivity or work absence, the two potential channels through which firms may be affected. Following previous literature (e.g., Bennedsen et al., 2019), we use the log of sales per employee as a measure of employee productivity and estimate our baseline specification in Equation (2) with this variable as the outcome. The results, shown in Column (1) of Appendix Table A3, suggest that more CRP tests are weakly associated with lower productivity: a one standard deviation increase in the average number of CRP tests in a firm leads to a reduction of approximately 0.01% in sales per worker.

The second channel through which poor employee health might affect their employers is if employees are absent from work. Statistics Denmark provides information on work absences from a survey of approximately 2,600 privately-owned firms with at least 10 employees, similar to the firms in our sample.[1] The data start in 2013 and are aggregated at the regional level.[2] We construct two measures over the latter part of our sample period, 2013–2016: (1) the absence rate for own and child sickness, defined as the percentage of the possible days of work when employees are absent from work due to own or child sickness, and (2) the average number of days of absence per full-time employee, where the absence is again due to own or child sickness. We add to these data the region-level average number of CRP tests per firm for the firms in our sample, and we estimate specifications similar in spirit to Equation (2):

$$A_{rt} = \alpha_t + \nu_r + \beta \times CRP\_tests_{rt} + \epsilon_{rt}, \tag{A1.1}$$

where A_{rt} is one of our measures of work absence in region r and year t, CRP_tests_{rt} is the region-level average number of CRP tests among the firms in our sample, and α_t and ν_r are year and region fixed effects.

The results suggest that more CRP tests are indeed associated with more absences from work. Column (2) in Appendix Table A3 indicates that a one standard deviation increase in the average number of CRP tests per person in a region is associated with an increase of 0.05 percentage points in the absence rate in the region, and Column (3) that it is associated with 0.11 more days of absence from work.[3] These estimates represent increases of 1.5% when compared to the average absence rate and the average number of days of absence. Although not causal and imprecisely estimated on a small sample, they suggest that a more severe flu season is associated with more work absence.

Taken together, the evidence in this section suggests that a more severe flu season leads, at the

[1] Persons suffering from chronic illness or in flexible jobs are excluded from the calculation of the absence statistics.
[2] Denmark is divided into 5 regions.
[3] The results from specifications weighted by region population are qualitatively and quantitatively similar.

very least, to more absences from work. Firms would then need to make up for the absences (or loss of productivity) of their workers. They can do so by substituting capital for labor, hiring temporary workers, or shifting healthy workers across tasks. The first two strategies have clear cost implications for firms that rely relatively more on labor inputs, while the last one may be feasible only in firms with a large enough workforce. Therefore, we expect to find that the effects of poor employee health vary across the distribution of firms by labor intensity, financial flexibility, or size.

A2 Robustness analysis

In this section, we check the sensitivity of our results to several alternative specifications. In particular, we address concerns that our findings may be driven by longer-term effects of severe influenza seasons, by years of economic downturn, by firms that are located in the largest and most densely populated municipality in Denmark (Copenhagen), or by the specific way we measure how the flu affects employee health.

We first examine whether seasonal influenza-induced health shocks last beyond the year of occurrence. We add the lagged number of CRP tests in a firm to our baseline specification and report the results in Column (1) of Appendix Table A4. The estimated coefficient for the lagged value of the number of CRP tests in a firm is smaller and statistically insignificant, while the estimated effect of the contemporaneous number of CRP tests is virtually identical to our baseline estimate in Table 2. This confirms that the health shock and its effects are indeed temporary.

Another potential concern is that the general economic situation might taint our estimates if influenza outbreaks overlap with periods of economic slowdown, resulting in lower firm profitability. For those economic conditions to drive our results, the cross-firm variation in economic slowdown would need to closely mirror the cross-firm variation in the severity of influenza. While we believe that is an unlikely scenario, excluding years of negative and low economic growth from our analysis should help reassure us that our results are not driven by exposure to periods of economic slowdown. There are two such periods during our sample period, 2001–03 and 2008–09, where real annual GDP growth in Denmark fell below 1%. Growth in this period marks a sharp contrast to the average real GDP growth in other years, which exceeds 2%. We exclude these periods from the sample and report the results in Column (2) of Appendix Table A4. Our estimates are very similar to our baseline results. We, therefore, conclude that changes in the state of the economy are unlikely to be driving the findings of our analysis.

Next, we consider the potentially outsized influence of Copenhagen municipality. It is the largest municipality of Denmark, and also the largest of the four municipalities that constitute the City of Copenhagen (the capital). This municipality had a population of more than 600,000 inhabitants in 2016, corresponding to about 9.5% of Denmark's total population, and hosts a number of the largest firms. All these factors suggest that firms in this municipality could react differently when their employees catch the flu. We re-estimate our baseline specification after excluding all the firms located in this municipality. Column (3) shows that this does not alter our main findings.

Finally, we examine the sensitivity of our findings to the specific way we measure health shocks. In Column (4), we show that the results remain qualitatively similar, though slightly more imprecise if we measure shocks to employee health through an indicator that takes the value of one for all firm years in which the number of CRP tests in a firm exceeds 80% of the sample mean.

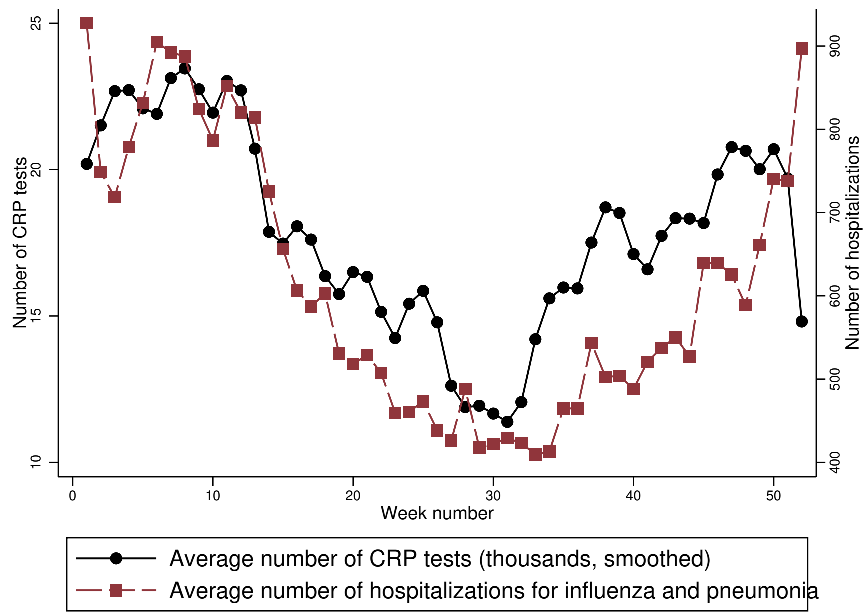
We then construct two measures of employee health based on hospitalizations for influenza and its main complication, pneumonia. The main advantage of using such alternative measures is that we know the exact diagnosis for a hospital visit and are not relying on a proxy for the severity of the influenza season. The main disadvantage is that such hospitalizations are relatively extreme events that occur much less frequently than GP visits. Consequently, we can construct these hospitalization-based measures only at a more aggregate level, such as the municipality. We first calculate the rate of hospitalizations for influenza and pneumonia for every municipality and every year. We then assign this municipality-level rate to each firm year based on firm locations and construct a health shock indicator that takes a value of one for all firm years in which the flu-related hospitalization rate in the firm's municipality is above 80% of the sample mean. Note that we are not able to include municipality fixed effects in this specification because this measure varies at the municipality level. The results listed in Column (5) indicate again that a more severe flu season leads to a decline in firm profitability. The second measure we construct is a firm-specific hospitalization-based measure using the information on the municipality of residence of the firm's employees. For each firm and each year, we calculate a weighted average of municipality-level flu-related hospitalization rates over all municipalities, with weights determined by the fraction of the firm's workforce that resides in that municipality. For example, if in a given year 60% of a firm's workforce resides in the municipality of Copenhagen and 40% in the municipality of Aarhus, our firm-specific flu-related hospitalization rate would assign a weight of 60% to the Copenhagen hospitalization rate, a weight of 40% to the Aarhus hospitalization rate, and a weight of 0% to the hospitalization rates of all the other municipalities in that year. We then create an indicator variable that takes the value of one whenever the number of relevant hospitalizations in a municipality year exceeds an 80% threshold in that distribution. This measure of flu exposure varies by firm within a municipality and thus allows us to include municipality-year fixed effects in our estimation. These will account for all omitted local shocks that can affect firm performance. Column (6) shows that we still find statistically significant negative effects of a severe flu season on firm performance.

A3 Size results at the establishment level

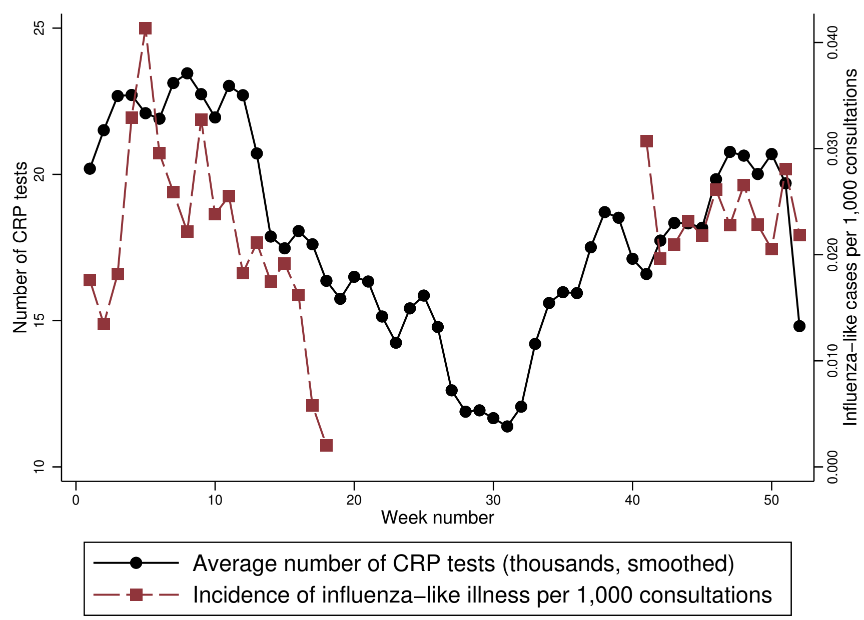
We can leverage our establishment-level data to shed more light on the role firm size may play in modulating the effect of employee health on operating performance. The results discussed thus far are consistent with the notion that larger firms can reallocate resources better than smaller firms and might consequently absorb labor productivity shocks associated with employee health. This mechanism would imply that establishments are impacted differently depending on whether they are part of a larger or a smaller corporation. We test this conjecture in a subset of multi-establishments firms by comparing the effect of employee health on firm performance between similarly sized small establishments owned by firms of different sizes. If the redistribution of resources within firms helps explain our findings, we would expect to find a weaker relationship between health shocks and performance for establishments that are part of a larger firm. We report the results in Appendix Table A8. Two observations emerge. First, across various specifications, we continue to find that health shocks negatively impact firm performance in small establishments. Second, this relationship is insignificant and economically less pronounced when the establishment is part of a larger corporation. In summary, we find that it is not only the size of the establishment that matters for how well it can absorb the detrimental effects of influenza outbreaks but also the size of the parent firm, which makes it plausible that the reallocation of resources by the parent firm may help absorb those shocks.

References

Bennedsen, Morten, Margarita Tsoutsoura, and Daniel Wolfenzon. 2019. "Drivers of Effort: Evidence from Employee Absenteeism." *Journal of Financial Economics* 133 (3): 658–684.



(a) Hospital admissions for influenza and pneumonia (viral or bacterial)



(b) Incidence of influenza-like illness per 1,000 GP consultations

Notes: Each dot represents the weekly number of CRP tests or of hospital admissions for influenza and pneumonia, or the weekly incidence rate of influenza-like illness, averaged across years. The data on CRP tests and hospital admissions come from our sample and cover the entire sample period 1999–2016. The data on influenza-like illness come from InfluenzaNet (available at `https://influenzanet.info`) and are based on self-reported illness over the period 2014–2016. Because of spikes in certain weeks (typically multiples of 4, likely due to the filing of reimbursement claims at the end of the month), the number of CRP tests reported is smoothed using a local polynomial of degree one and an Epanechnikov kernel.

Figure A1: Average weekly number of CRP tests and other indicators of influenza severity

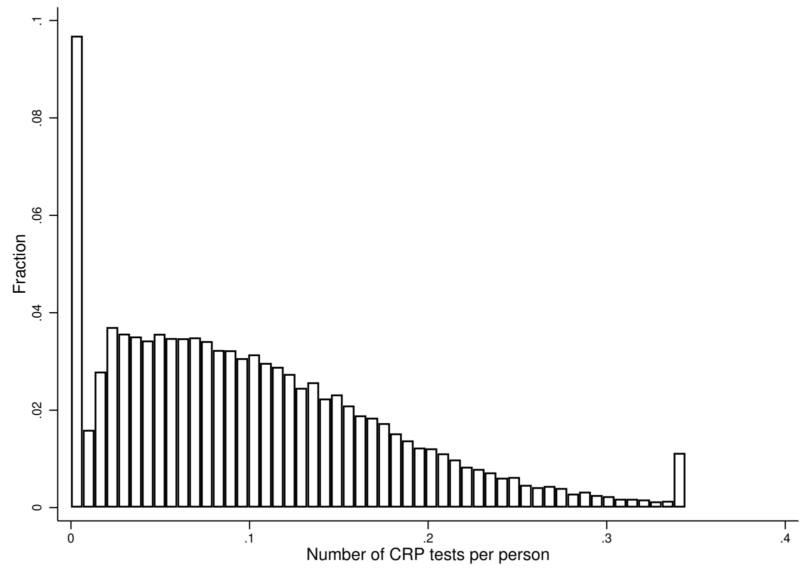


Figure A2: Distribution of the CRP Test Rate

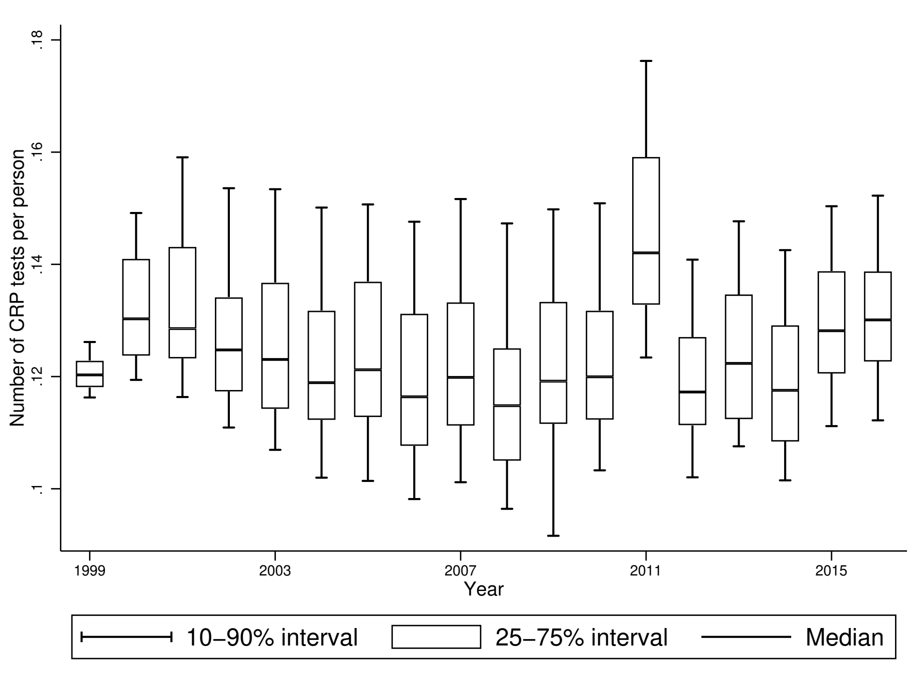
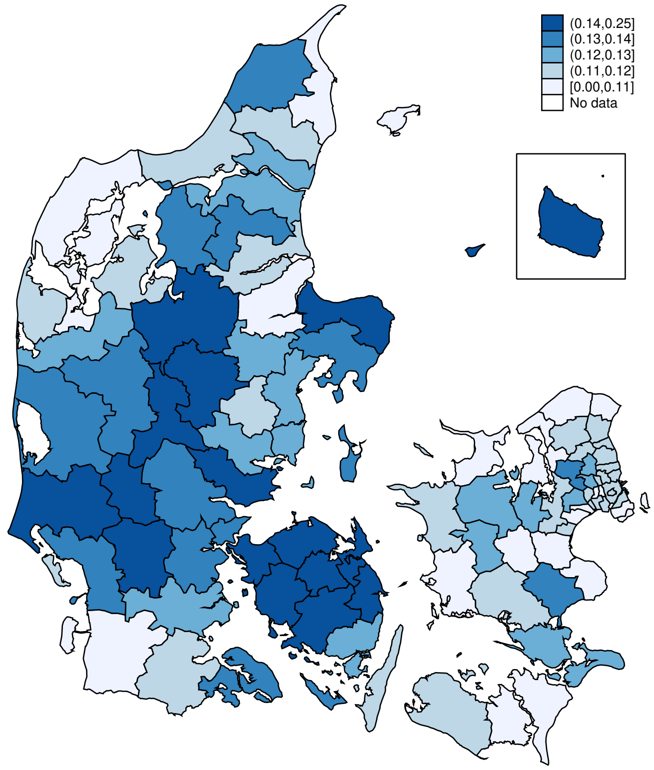
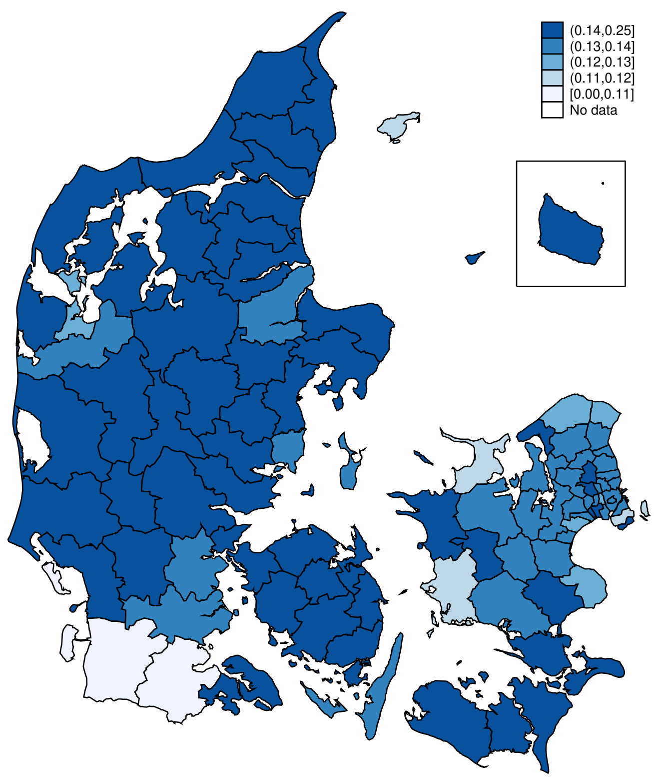


Figure A3: Evolution of the Distribution of the CRP Test Rate over Time



(a) 2004



(b) 2011

Figure A4: Distribution of the CRP Test Rate across Danish Municipalities and Time

Table A1: The Effect of Employee Health on Industry-Adjusted Firm Performance

This table examines the effect of employee health on firm operating performance. In Panel A, the dependent variable is an industry-adjusted operating return on assets (OROA). OROA is defined as the ratio of operating income to total assets, and the industry-adjusted version is calculated by taking the difference between a firm's OROA and the average OROA in its 4-digit industry according to the NACE 2.0 classification. In Panel B, the dependent variable is industry-adjusted net income to total assets (NI), defined similarly. To measure employee health, we examine the number of CRP tests performed on employees and their families during the flu season. Firm controls include Log(Assets), the natural logarithm of the lagged value of total assets; Market concentration (HHI), measured by the Herfindahl-Hirschmann index of the firm's industry; N days at hospital (avg) — Top-5 employee / Rank and file employee, the average number of days a top-5 / non-top-5 employee was hospitalized in a given year; Local controls (municipality) — Population density / Unemployment rate, the population density of / unemployment rate in the firm's municipality. All variables are winsorized at the 1% level and all specifications focus on firms with at least ten employees and include firm fixed effects. Columns (1) and (3) also include year fixed effects, while Columns (2) and (4) use municipality times year fixed effects. Columns (3) and (4) further include firm age dummies for every five-year bin of firm age. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Industry-adjusted OROA			
	(1)	(2)	(3)	(4)
CRP tests	−0.0168**	−0.0172**	−0.0182**	−0.0179**
	(0.0075)	(0.0076)	(0.0076)	(0.0078)
Log(Assets)			−0.0115***	−0.0115***
			(0.0012)	(0.0012)
Market concentration (HHI)			−0.0295**	−0.0259*
			(0.0137)	(0.0139)
Top-5 employee, N days at hospital (avg)			−0.0014***	−0.0015***
			(0.0005)	(0.0005)
Rank and file employee, N days at hospital (avg)			−0.0010	−0.0010
			(0.0007)	(0.0007)
Municipality density			−0.0032	
			(0.0190)	
Unemployment rate			−0.2600***	
			(0.0867)	
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.315	0.315	0.319	0.319

	Panel B: Industry-adjusted Net Income			
	(1)	(2)	(3)	(4)
CRP tests	−0.0162**	−0.0167**	−0.0165**	−0.0167**
	(0.0070)	(0.0072)	(0.0072)	(0.0073)
Log(Assets)			−0.0100***	−0.0101***
			(0.0012)	(0.0012)
Market concentration (HHI)			−0.0226*	−0.0195
			(0.0130)	(0.0131)
Top-5 employee, N days at hospital (avg)			−0.0010**	−0.0011**
			(0.0005)	(0.0005)
Rank and file employee, N days at hospital (avg)			−0.0010	−0.0009
			(0.0007)	(0.0007)
Municipality density			0.0076	
			(0.0176)	
Unemployment rate			−0.1884**	
			(0.0804)	
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.298	0.298	0.300	0.300

Table A2: The Magnitude of the Effect of Employee Health on Firm Performance

This table details the magnitude of the effect of employee health on firm operating performance. In Panel A, the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets. In Panel B, the dependent variable is net income to total assets (NI). In Panels C and D, the dependent variables are the industry-adjusted versions of OROA and NI, respectively, calculated as the difference between the measure of profitability and its average at the 4-digit industry according to the NACE 2.0 classification. To measure employee health, we examine the number of CRP tests performed on employees and their families during the flu season. Profit refers to operating return in Panel A and net income in Panel B. Firm controls include Log(Assets), the natural logarithm of the lagged value of total assets; Market concentration (HHI), measured by the Herfindahl-Hirschmann index of the firm's industry; N days at hospital (avg) — Top-5 employee / Rank and file employee, the average number of days a top-5 / non-top-5 employee was hospitalized in a given year; Local controls (municipality) — Population density / Unemployment rate, the population density of / unemployment rate in the firm's municipality. All variables are winsorized at the 1% level and all specifications focus on firms with at least ten employees and include firm fixed effects. Columns (1) and (3) also include year fixed effects while Columns (2) and (4) use municipality times year fixed effects. Columns (3) and (4) further include firm age dummies for every five-year bin of firm age. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: OROA			
	(1)	(2)	(3)	(4)
Effect of 1s.d. in CRP tests	−0.0015**	−0.0013**	−0.0015**	−0.0013**
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
— relative to median performance	−0.0233**	−0.0200**	−0.0232**	−0.0204**
	(0.0095)	(0.0097)	(0.0095)	(0.0097)
— relative to average performance	−0.0236**	−0.0202**	−0.0233**	−0.0205**
	(0.0096)	(0.0098)	(0.0095)	(0.0097)
— relative to s.d. of performance	−0.0082**	−0.0070**	−0.0083**	−0.0073**
	(0.0033)	(0.0034)	(0.0034)	(0.0035)
— on average profit ('000 DKK)	−68.0778**	−58.2729**	−68.8352**	−60.3633**
	(27.7772)	(28.2026)	(28.1638)	(28.6942)
— on average profit ('000 USD)	−10.8289**	−9.2692**	−10.9493**	−9.6017**
	(4.4184)	(4.4861)	(4.4799)	(4.5643)
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.343	0.344	0.347	0.347

	Panel B: Net Income			
	(1)	(2)	(3)	(4)
Effect of 1s.d. in CRP tests	−0.0015**	−0.0013**	−0.0014**	−0.0013**
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
— relative to median performance	−0.0566**	−0.0505**	−0.0538**	−0.0498**
	(0.0222)	(0.0226)	(0.0219)	(0.0222)
— relative to average performance	−0.0817**	−0.0729**	−0.0745**	−0.0690**
	(0.0320)	(0.0325)	(0.0303)	(0.0308)
— relative to s.d. of performance	−0.0087**	−0.0077**	−0.0085**	−0.0079**
	(0.0034)	(0.0034)	(0.0034)	(0.0035)
— on average profit ('000 DKK)	−67.0965**	−59.8836**	−65.7308**	−60.8410**
	(26.3129)	(26.7188)	(26.7061)	(27.1818)
— on average profit ('000 USD)	−10.6728**	−9.5254**	−10.4555**	−9.6777**
	(4.1855)	(4.2501)	(4.2480)	(4.3237)
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.325	0.325	0.327	0.327

Table A2 (cont.): The Magnitude of the Effect of Employee Health on Firm Performance

	Panel C: Industry-adjusted OROA			
	(1)	(2)	(3)	(4)
Effect of 1s.d. in CRP tests	-0.0013^{**}	-0.0014^{**}	-0.0014^{**}	-0.0014^{**}
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
— relative to s.d. of performance	-0.0076^{**}	-0.0078^{**}	-0.0083^{**}	-0.0081^{**}
	(0.0034)	(0.0035)	(0.0034)	(0.0035)
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.315	0.315	0.319	0.319
	Panel D: Industry-adjusted Net Income			
	(1)	(2)	(3)	(4)
Effect of 1s.d. in CRP tests	-0.0013^{**}	-0.0013^{**}	-0.0013^{**}	-0.0013^{**}
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
— relative to s.d. of performance	-0.0079^{**}	-0.0082^{**}	-0.0081^{**}	-0.0081^{**}
	(0.0034)	(0.0035)	(0.0035)	(0.0036)
Controls	No	No	Yes	Yes
Fixed effects	Firm and year	Firm and muni x year	Firm and year	Firm and muni x year
N	194,073	194,050	183,917	183,892
R^2	0.298	0.298	0.300	0.300

Table A3: The Relationship between Employee Health and Employee Performance

This table examines the relationship between employee health and measures of employee performance. The specification in Column (1) is our baseline specification in Equation (2) estimated in our sample of firms, with the log of sales per full-time equivalent as the dependent variable and our full set of controls (see the notes to Table 2 for details). The specifications in Columns (2) and (3) are based on Equation (A1.1) and rely on data aggregated at the region level over the period 2013–2016. The main independent variable is the region-level average number of CRP tests per person for the employees in the firms in our analysis sample and their family members. The dependent variable in Column (2) is the region-level average absence rate, defined as the percentage of the possible days of work when employees are absent from work due to their own or their child's sickness. The outcome in Column (3) is the region-level average number of days of absence per full-time employee, where the absence is again due to an employee's own or child's sickness. The information on work absence is reported by Statistics Denmark from a survey of approximately 2,600 private enterprises with 10 or more employees. Persons suffering from chronic illness or in flexible or light jobs are not included in the calculation of the absence statistics. All regressions include year and unit of observation (firm or region, respectively) fixed effects. Clustered (firm or region, respectively) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Firm-level data	Region-level data	
	Log(sales) / FTE (1)	Absence rate (%) (2)	Average absence days (3)
CRP tests	−0.0018	1.1909*	2.8258
	(0.0158)	(0.5448)	(1.4862)
Effect of 1 s.d. increase in CRP tests	−0.0001	0.0452*	0.107
	(0.0013)	(0.0207)	(0.056)
Mean of dependent variable	7.1849	2.910	6.977
Fixed effects	Firm and year	Region and year	Region and year
N	183,802	20	20
R^2	0.847	0.901	0.900

Table A4: Robustness Analysis

This table examines the effect of employee health on firm operating performance. The dependent variable in Panel A is operating return on assets (OROA). In Panel B, it is net income to assets. In column (1), we also include the one-year lagged CRP test. In column (2), we exclude years of economic slowdown (2001-03 and 2008/09) from the sample. In column (3), we exclude the largest municipality and capital of Denmark, i.e. Copenhagen. In column (4), we measure employee health by constructing a Health Shock indicator that takes a value of one for all firm years in which a firm's CRP test variable exceeds 80% of the sample mean. In column (5), we measure employee health by constructing a Health Shock indicator that takes the value one for all firm years in which a firm's municipality reports flu-related hospitalization events in excess of 80% of the sample mean. In column (6), we use an alternative measure of employee health by examining the employee-weighted average of flu-related hospitalization events from employees' municipalities of residence. We then create a Health Shock indicator that takes a value of one for all firm years in which a firm's measure of flu exposure is in excess of 80% of the sample mean. In columns (1) to (6), we include firm and year fixed effects, and in column (6), we replace these fixed effects with municipality times year fixed effects. All variables are winsorized at the 1% level and all specifications include our full set of firm-level and municipality-level controls and firm age dummies for every five-year bin of firm age. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: OROA					
	(1)	(2)	(3)	(4)	(5)	(6)
CRP tests	−0.0185**	−0.0183**	−0.0167**			
	(0.0077)	(0.0086)	(0.0079)			
CRP tests (t-1)	−0.0091					
	(0.0082)					
Treatment				−0.0024*	−0.0022*	−0.0046*
				(0.0012)	(0.0012)	(0.0027)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Municipality × year
N	183,105	129,613	166,950	183,917	183,920	186,988
R^2	0.348	0.358	0.345	0.347	0.347	0.027
	Panel B: Net income					
	(1)	(2)	(3)	(4)	(5)	(6)
CRP tests	−0.0176**	−0.0178**	−0.0168**			
	(0.0074)	(0.0081)	(0.0074)			
CRP tests (t-1)	−0.0090					
	(0.0077)					
Treatment				−0.0023*	−0.0022*	−0.0039
				(0.0012)	(0.0011)	(0.0025)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Municipality × year
N	183,105	129,613	166,950	183,917	183,920	186,988
R^2	0.328	0.337	0.323	0.327	0.327	0.026

Table A5: The Effect of Employee Health by Labor/Capital Intensity

This table shows the effect of employee health on firm operating performance by labor/capital intensity. To measure labor intensity and capital intensity, we first compute the ratio of wages to revenues (WtR) and the ratio of total assets to revenues (AtR) for each firm in our sample. We then define an indicator, *Labor Intensive*, which takes a value of one for all firm years with above-average WtR and below-average AtR ratios. Similarly, we define *Capital Intensive*, an indicator that takes a value of one for all firm years with below-average WtR and above-average AtR ratios. In Columns (1)–(3), the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets, and in Columns (4)–(6), it is net income to total assets (NI). All variables are winsorized at the 1% level. All specifications focus on firms with at least ten employees and include firm and year fixed effects, age dummies for every five-year bin of firm age, and our full set of firm-level and municipality-level controls. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	OROA			Net Income		
	(1)	(2)	(3)	(4)	(5)	(6)
CRP tests	0.0005	−0.0205**	−0.0004	−0.0035	−0.0198***	−0.0052
	(0.0086)	(0.0080)	(0.0089)	(0.0081)	(0.0076)	(0.0085)
Labor Intensive	0.0072***		0.0074***	0.0016		0.0017
	(0.0021)		(0.0021)	(0.0020)		(0.0020)
Labor Intensive × CRP tests	−0.0435***		−0.0423***	−0.0328***		−0.0307**
	(0.0128)		(0.0131)	(0.0119)		(0.0121)
Capital Intensive		0.0036	0.0057**		0.0062**	0.0073***
		(0.0027)	(0.0027)		(0.0025)	(0.0025)
Capital Intensive × CRP tests		0.0245	0.0075		0.0272*	0.0146
		(0.0171)	(0.0173)		(0.0164)	(0.0166)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,917	183,917	183,917	183,917	183,917	183,917
R^2	0.347	0.347	0.347	0.327	0.327	0.327

Table A6: The Effect of Employee Health by Financial Flexibility

This table shows the effect of employee health on firm operating performance by level of financial flexibility. In Panel A, the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets, and in Panel B, it is net income to total assets (NI). We construct the measure of financial constraint proposed by Schauer et al. (2019) and define a firm as financially constrained or unconstrained if its measure lies above or below a certain percentile in the yearly distribution of the financial constraint measure, respectively. We include an indicator for financially unconstrained firms and its interactions with the CRP test variable (so that the baseline estimate for the CRP tests variable represents the effect for financially constrained firms), and we vary the threshold for financially-constrained firms between the 50^{th} and the 90^{th} percentile in increments of 5 percentage points. All variables are winsorized at the 1% level. All specifications focus on firms with at least ten employees and include firm and year fixed effects, age dummies for every five-year bin of firm age, and our full set of firm-level and municipality-level controls. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Percentile of the distribution of financial constraint measure								
	50	55	60	65	70	75	80	85	90
	Panel A: OROA								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CRP tests	−0.0197**	−0.0251***	−0.0264***	−0.0293***	−0.0377***	−0.0463***	−0.0470***	−0.0533***	−0.0650***
	(0.0090)	(0.0093)	(0.0097)	(0.0102)	(0.0109)	(0.0119)	(0.0131)	(0.0150)	(0.0181)
CRP tests × Unconstrained firm	0.0036	0.0139	0.0144	0.0187*	0.0294***	0.0399***	0.0379***	0.0431***	0.0542***
	(0.0103)	(0.0102)	(0.0102)	(0.0105)	(0.0109)	(0.0117)	(0.0128)	(0.0145)	(0.0176)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,917	183,917	183,917	183,917	183,917	183,917	183,917	183,917	183,917
R^2	0.353	0.353	0.352	0.352	0.351	0.351	0.350	0.349	0.348
	Panel B: Net Income								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CRP tests	−0.0235***	−0.0286***	−0.0298***	−0.0339***	−0.0428***	−0.0503***	−0.0534***	−0.0602***	−0.0731***
	(0.0085)	(0.0089)	(0.0093)	(0.0098)	(0.0105)	(0.0113)	(0.0126)	(0.0144)	(0.0174)
CRP tests × Unconstrained firm	0.0142	0.0229**	0.0224**	0.0280***	0.0388***	0.0469***	0.0477***	0.0529***	0.0648***
	(0.0097)	(0.0097)	(0.0097)	(0.0099)	(0.0104)	(0.0111)	(0.0123)	(0.0140)	(0.0169)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,917	183,917	183,917	183,917	183,917	183,917	183,917	183,917	183,917
R^2	0.333	0.333	0.333	0.332	0.332	0.331	0.331	0.330	0.329

Table A7: The Effect of Employee Health on Firm Performance and Firm Size

This table shows that the effect of employee health on firm operating performance depends on firm size. In Columns (1) and (2), the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets. In Columns (3) and (4), the dependent variable is net income to total assets (NI). We use terciles of the distribution of full-time equivalent (FTE) to define firm size categories. The resulting categories are as follows: *Small firms* with more than 10 but less than 16 FTE and *Medium-sized firms* with between 16 and 32 FTE. We include indicators that identify firms in these categories, and their interactions with the CRP test variable, as shown in the table. All variables are winsorized at the 1% level. All specifications focus on firms with at least ten employees, use firm and year fixed effects, and include our full set of firm-level, municipality-level, and age-bucket controls. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	OROA		Net Income	
	(1)	(2)	(3)	(4)
CRP tests	0.0071	0.0207	0.0117	0.0248*
	(0.0123)	(0.0157)	(0.0114)	(0.0145)
Below median	−0.0098***		−0.0105***	
	(0.0024)		(0.0023)	
Below median × CRP tests	−0.0377***		−0.0431***	
	(0.0135)		(0.0125)	
Medium-sized		−0.0015		−0.0030
		(0.0028)		(0.0026)
Medium-sized × CRP tests		−0.0408**		−0.0460***
		(0.0171)		(0.0157)
Small		−0.0100***		−0.0135***
		(0.0034)		(0.0031)
Small × CRP tests		−0.0512***		−0.0541***
		(0.0175)		(0.0162)
Controls	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year
N	183,917	183,917	183,917	183,917
R^2	0.347	0.347	0.327	0.327

Table A8: Measuring the Effect on Small Establishments of Large Firms

This table compares the effect of employee health on establishment operating performance between similarly sized *small* establishments owned by firms of *different sizes*. The dependent variable is *Profit per employee*, the ratio of establishment gross profit to the full-time employee equivalent of the establishment. To measure employee health, we examine the number of CRP tests performed on employees and their families during the flu season. We define large firms as indicated by the row *Firm cutoff: above*, where full-time employment exceeds the 75^{th} percentile of its distribution or an absolute value of 100, respectively. Establishments of these firms are identified with the *in-large* indicator, which we interact with our CRP-test measure. We restrict the sample to include small establishments as indicated by the row *Establishment cutoff: below*, where establishment employment lies below the 50^{th} percentile, the 25^{th} percentile, or an absolute value of 15, respectively. The interaction term between CRP-tests and the in-large indicator isolates the effect of a health shock on small establishments that are part of a larger firm. Control variables are described in Table 3. All variables are winsorized at the 1% level. Clustered (establishment) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Profit per employee		
Firm cutoff: above	75^{th} FTE pctl.	75^{th} FTE pctl.	100 FTE
Establishment cutoff: below	50^{th} FTE pctl.	25^{th} FTE pctl.	15 FTE
	(1)	(2)	(3)
CRP tests	-0.1048^{*}	-0.2167^{**}	-0.1317
	(0.0557)	(0.1023)	(0.0882)
CRP tests × in-large	0.0324	0.1807	0.0805
	(0.0744)	(0.1184)	(0.1027)
Controls	Yes	Yes	Yes
Fixed effects	Firm x year	Firm x year	Firm x year
N	16,352	6,922	9,446
R^2	0.818	0.813	0.828

Table A9: Distribution of Estimated Vaccine Efficacy Ratio

This table shows the distribution of the estimated vaccine efficacy ratio based on Equation (4). Panel A presents the measure at the firm-year level and Panel B at the firm level. In both cases, we describe the distribution in the full sample and by size, for small and medium-sized firms. Column (1) lists the mean, and Columns (2)–(5) selected percentiles. Finally, Column (6) shows the percentage of firm-years (Panel A) or of firms (Panel B) with an estimated vaccine efficacy ratio below 40%.

	Distribution of vaccine efficacy ratio					Percent lower than 40%
	Mean	Percentile				
		50^{th}	75^{th}	90^{th}	95^{th}	
	(1)	(2)	(3)	(4)	(5)	(6)
A. Vaccine efficacy ratio, firm-year level						
Full sample	39.04	17.58	45.00	100.00	108.89	72.57
Firm size:						
Small	30.65	12.79	37.04	100.00	100.00	76.34
Medium-sized	37.96	17.29	43.92	100.00	106.91	76.34
B. Vaccine efficacy ratio, firm level						
Full sample	44.53	30.85	56.96	89.06	109.74	60.92
Firm size:						
Small	32.43	21.12	47.67	76.63	100.00	69.60
Medium-sized	43.57	25.98	54.70	97.97	109.41	64.94

Table A10: The Effect of Employee Health by Industry

This table shows the effect of employee health on firm operating performance by industry. We focus on wholesale/retail and manufacturing/construction industries. To identify these industries, we define an indicator, *Wholesale/Retail*, which takes a value of one for all firms with a NACE 2.0 industry classification between 45 and 47. Similarly, *Manufact/Construct* is an indicator that takes a value of one for all firms with a NACE 2.0 industry classification between 10 and 33, and between 41 and 43. In Columns (1)–(3), the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets, and in Columns (4)–(6), it is net income to total assets (NI). All variables are winsorized at the 1% level. All specifications focus on firms with at least ten employees and include firm and year fixed effects, age dummies for every five-year bin of firm age, and our full set of firm-level and municipality-level controls. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	OROA			Net Income		
	(1)	(2)	(3)	(4)	(5)	(6)
CRP tests	−0.0294***	0.0114	0.0171	−0.0271***	0.0079	0.0128
	(0.0092)	(0.0099)	(0.0165)	(0.0087)	(0.0094)	(0.0158)
Wholesale/Retail	−0.0084		−0.0120	−0.0056		−0.0096
	(0.0063)		(0.0100)	(0.0060)		(0.0095)
Wholesale/Retail × CRP tests	0.0375***		−0.0109	0.0323***		−0.0092
	(0.0132)		(0.0195)	(0.0122)		(0.0183)
Manufacturing/Construction		0.0033	−0.0044		0.0012	−0.0050
		(0.0055)	(0.0087)		(0.0051)	(0.0082)
Manufacturing/Construction × CRP tests		−0.0638***	−0.0696***		−0.0547***	−0.0598***
		(0.0135)	(0.0193)		(0.0125)	(0.0182)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,917	183,917	183,917	183,917	183,917	183,917
R^2	0.347	0.347	0.347	0.327	0.327	0.327

Table A11: Workforce Characteristics and the Effect of Employee Health on Firm Performance

This table shows how the effect of employee health on firm operating performance varies with workforce characteristics. In Panel A, the dependent variable is operating return on assets (OROA), the ratio of operating income to total assets. In Panel B, it is net income to total assets (NI). To measure the differential effect of workforce characteristics on employee health, we examine subgroups of employees with similar characteristics and separately calculate the number of CRP tests performed on these employees and their families during the flu season. All variables are winsorized at the 1% level and all specifications focus on firms with at least ten employees, use firm, year, and industry fixed effects, and include our full set of firm-level, municipality-level, and age-bucket controls. We further include the fraction of employees of the respective subgroups as additional controls. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Number of CRP tests among:	OROA					Net income				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Low salary employees	−0.0118***					−0.0112***				
	(0.0043)					(0.0041)				
Medium salary employees	−0.0028					−0.0022				
	(0.0060)					(0.0057)				
High salary employees	−0.0063					−0.0072*				
	(0.0044)					(0.0042)				
Employees in low skill occ.		−0.0096**					−0.0084*			
		(0.0048)					(0.0045)			
Employees in high skill occ.		−0.0012					−0.0006			
		(0.0047)					(0.0044)			
Employees w/o college			−0.0133					−0.0132*		
			(0.0084)					(0.0079)		
Employees w/ college			−0.0002					−0.0001		
			(0.0034)					(0.0032)		
≤34 yrs old employees				−0.0021					−0.0008	
				(0.0047)					(0.0045)	
35–54 yrs old employees				−0.0119**					−0.0137**	
				(0.0060)					(0.0056)	
55+ yrs old employees				0.0015					0.0013	
				(0.0025)					(0.0024)	
Employees w/ kids					−0.0040					−0.0021
					(0.0050)					(0.0048)
Employees w/o kids					−0.0166***					−0.0164***
					(0.0064)					(0.0061)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry	Firm, year, and industry
N	173,385	173,385	173,385	173,385	173,385	173,385	173,385	173,385	173,385	173,385
R^2	0.350	0.350	0.350	0.350	0.350	0.330	0.330	0.330	0.330	0.330

Table A12: The Effect of Employee Health on Workforce and Firm Owners

This table shows how employee health affects the firm's workforce and owners. Columns (1) to (3) present results for workers. We measure worker outcomes in several ways. The ratio of log sales over the number of employees is our measure of productivity. We capture total workforce size and salaries with the natural logarithm of full-time equivalent employment and the natural logarithm of average yearly wages. In Column (4), the dependent variable is a dummy variable that is equal to one if a firm has expenses for temporary employment, and zero otherwise. In Column (5), the dependent variable, Cash, is the ratio of cash holdings to total assets, and in Column (6), Dividends is the ratio of dividends to total assets. We use terciles of the distribution of full-time equivalent (FTE) to define firm size categories. The resulting categories are as follows: *Small firms* with more than 10 but less than 16 FTE; *Medium-sized firms* with between 16 and 32 FTE; *Large firms*, with more than 32 FTE. All variables are winsorized at the 1% level. Clustered (firm) standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Worker			Firm		Owner
	Productivity (1)	Employment (2)	Wages (3)	Temp. Labor Dummy (4)	Cash (5)	Dividends (6)
CRP tests × Large	0.2349***	0.1576***	0.0844***	−0.1557***	−0.0252***	0.0100
	(0.0326)	(0.0313)	(0.0180)	(0.0453)	(0.0090)	(0.0065)
CRP tests × Medium-sized	0.0158	−0.0037	−0.0022	0.0333	0.0076	−0.0035
	(0.0232)	(0.0148)	(0.0125)	(0.0341)	(0.0060)	(0.0044)
CRP tests × Small	−0.0879***	−0.0249**	−0.0196*	0.0724**	−0.0012	−0.0107***
	(0.0206)	(0.0106)	(0.0111)	(0.0290)	(0.0051)	(0.0037)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year	Firm and year
N	183,802	183,918	183,043	183,918	183,917	183,917
R^2	0.848	0.951	0.875	0.151	0.442	0.324